Analyze Aloe Vera Growth and Gel Production

LESSON OBJECTIVE Students will write and solve inequalities to analyze production of aloe vera gel.

LANGUAGE OBJECTIVES Students will use conditional and mathematical language to describe possible plans to solve real-world problems that involve inequalities.

PREREQUISITE SKILLS Solve equations of the form $px + q = r$.

Teachers can use the Imagine Math Standards Report and the Benchmark Performance Level Report to evaluate student readiness to complete this task.

COLLEGE AND CAREER READINESS STANDARDS FOR MATHEMATICS 7.EE.B.4.B

CCSS MATH	TEKS MATH	QSC
7.EE.B.4.B	7.10.B, 7.11.A	275, 276

Teacher Preparation

LESSON OVERVIEW Students develop plans to produce enough aloe vera gel to fill orders by writing and solving algebraic inequalities. They use number lines to check their work.

MATERIALS
- Algebra tiles
- Vocabulary Knowledge Rating Sheet
- Poster boards and markers

Understand Science Background

Plants have been used in traditional medicine practices since prehistoric times. Originally based in folk knowledge, medicinal compounds derived from plants are now the subject of serious scientific investigations. Plants create hundreds of biologically active compounds, known as phytochemicals, for various functions such as defense against insects, diseases, and animals. While many of these chemicals have been identified as having potential positive biological effects on humans, the effects of using all the chemicals in an entire plant as medicine are largely uncertain. Furthermore, the medicinal effects of plants largely remain untested by rigorous medical studies. In fact, from 1999 to 2012, only two botanical drugs had sufficient medical evidence to be approved by the US Food and Drug Administration.

One successful medicinal plant is the willow tree, which appears in sources as far back as clay tablets from ancient Sumeria and papyrus documents from ancient Egypt. In ancient times, chewing on bark from a willow tree or drinking it as a tea was known to relieve pain, fever, and inflammation. In the mid-1800s, pharmacists identified salicylic acid as the ingredient responsible for the healing effects of willow bark. Just a few years later, scientists figured out how to synthesize it. The result, aspirin, became one of the most effective drugs of the time, even though the mechanism behind why it works was not discovered until 1971. Although some of aspirin's side effects and interactions with other drugs remain unknown, aspirin is one of the most commonly used pain relievers in the world.

Collaborate: Work with science, literacy, and health teachers to expand cross-curricular experiences for students.

A more recent success story involves vinblastine and vincristine, both derived from the rose periwinkle, a common flowering herb found in the rain forests of Madagascar. After studying how traditional Madagascan healers use rose periwinkle to treat diabetes, Western scientists discovered that the plant was also effective in treating cancer. Vinblastine and vincristine are now among the most effective and widely used cancer drugs, especially in the treatment of Hodgkin's disease and childhood leukemia.

Even after millennia of using them as medicine, it appears that we have just begun to tap into the powerful healing properties of plants. By using scientific principles to better understand the complex healing powers of plants, new kinds of medicine will continue to be developed.

Pre-Task Class Activities

Engage in Discussion

Engage students by discussing what they know about where we get our medicine from. Direct students to the examples provided on page 1. Guide the discussion toward the concept of inequalities to help students understand the **Essential Question**. Direct students to use the **Supporting Words** and **Conditional Language** on pages 2 and 3 during their conversations. You may also use sentence stems to support your students' language usage in context.

Possible Discussion Topics

1. Discuss the dosages listed on page 1. How can the dosages be written using inequalities? Let the variable d represent the recommended dosage in milligrams.
   - For the medicine _____, $d \geq$ _____ and $d \leq$ _____.
2. Compare the dosages of the drugs on page 1. Why would there be a variation within the dosage of a drug? Why are the dosages so different between different drugs?
3. Present and discuss the following statistics: Over 25% of today's medicines are derived from plants. Over half of the plant species used by humans are used for medicinal purposes (other uses include food, clothing, and shelter).
4. Find, share, and discuss examples of animals that ingest certain plants to cure or relieve symptoms of an illness or disease. Examples may include other primates, monarch butterflies, and sheep.
5. Share and discuss examples of products that include aloe vera gel.

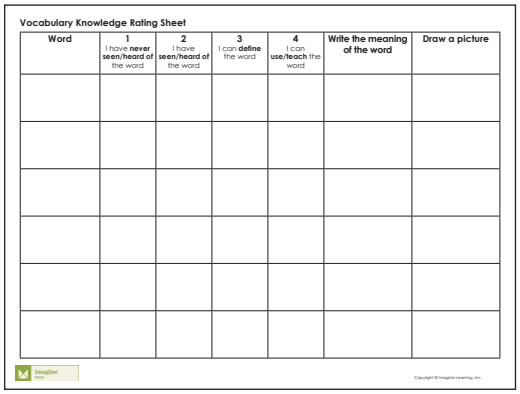
Products Containing Aloe Vera
Sunburn and burn relief ointments and balms
Dressings for minor wounds
Antibacterial agents and hand sanitizers
Makeup removers
Shaving cremes
Eczema and psoriasis unguents
Breath fresheners
Eyebrow gels
Exfoliators
Face washes

Review Vocabulary

Based on your students' language needs, use these activities to provide additional vocabulary support. Students should be prepared to meet the **Language Objective**.

Vocabulary Knowledge Rating Sheet

Ask students to choose four words from the **Supporting Words** and **Major Words** to write on a Vocabulary Knowledge Rating Sheet. Have students self-assess their knowledge of the words using the ratings 1–4 as shown on the sheet. Ask students to write what they think the word means in their own words. Then have them draw a picture of the word on their rating sheet.



Vocabulary Knowledge Rating Sheet

Word	1 I have never seen/heard of the word	2 I have seen/heard of the word	3 I can define the word	4 I can use/teach the word	Write the meaning of the word	Draw a picture

Discuss Cognates

Cognates are words from two different languages that share a common language origin. As a result, cognates often look or sound similar. The table shows some English and Spanish cognates from this lesson's vocabulary words. Cognates may similarly exist for other languages.

English	Spanish
aloe vera	*aloe vera*
dosage	*dosificación*
equation	*ecuación*
expression	*expresión*
latex	*látex*
medicinal plant	*planta medicinal*
order	*orden*
produce	*producir*

Additional Vocabulary Words

Every class has its own language needs. Based on your students' proficiency, you may wish to review some of the **Additional Words** used in this lesson that appear below. It may also be helpful to allow students to look up definitions of the **Supporting Words** and **Major Words** in their native languages.

ADDITIONAL WORDS

customer: someone who buys something

drug: any substance, other than food, that produces changes in the body

laxative: a type of medicine that regulates digestion and aids bowel movements

medicine: a drug used to cure or relieve the symptoms of diseases

moisturize: to make something less dry

Review Math Concepts

Depending on the needs of the students, use these teaching strategies to review and verify students' understanding of inequalities and ability to graph inequalities on a number line. Throughout the math review, maintain focus on the **Essential Question**.

Gallery Walk

Provide a large sheet of paper or poster board and some markers to each group of 3 to 4 students. Students will work together as a group to create a diagram, including a number line, to show the meaning of ***inequality*** by using an example from the medicinal plants on page 1 or from their own research. (Sample response: The medicine hyoscine, derived from the nightshade plant, is used to treat motion sickness. The recommended dosage is from 0.4 to 0.8 milligrams.) Under the illustration, each group should write an explanation, using cloze sentences as necessary.

- If d represents the recommended dosage, then $d \geq$ _____ and $d \leq$ _____.
- On a number line, the recommended dosage is represented as _____.

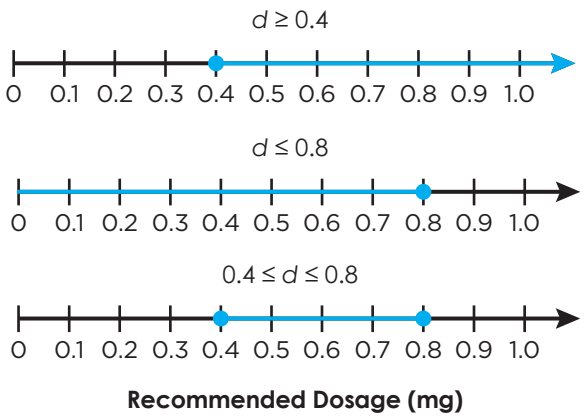
If students are unsure how to create a compound inequality graph including both a minimum and a maximum, ask them to graph each inequality on separate number lines. Then show students that the combined graph of both inequalities is the section of the number line where the two graphs overlap.

Display the finished posters around the classroom, and allow students to walk around and view the work of the other groups. Students can use adhesive notes to provide constructive criticism or ask questions. Alternatively, allow groups to present their posters and respond to questions from their peers.

Inequalities

Use one of the student-created diagrams, including the number line, from the **Gallery Walk**, to guide the whole class through writing inequalities and graphing them on a number line. Solicit student interaction to draw and label the diagram and the number line. Your completed diagram and number line should resemble the diagram and number line below and the number lines in **section D** in the lesson. Allow this diagram and number line to remain on display throughout the task for student reference. A diagram and number line for the **Gallery Walk** sample response is presented here.

Medicine Name: Hyoscine
Derived from: Nightshade plant
Treats: Motion sickness
Recommended dosage *d* (mg):
$d \geq 0.4$ and $d \leq 0.8$



The Application Task

Application Tasks are Performance Tasks where students apply their conceptual understanding and use procedural skills to solve a real-world problem. Application Tasks provide students the opportunity to demonstrate proficiency in multiple ways. Use the following ideas and modifications to ensure that students clearly understand the purpose, context, and constraints of the task. As students become more familiar with Application Tasks, less guidance may be needed.

Introduce the Essential Question

Direct students to the **Essential Question** on page 1. In this task, students will use inequalities to solve a real-world problem.

Make sure that students understand that the real-world problem in the **Essential Question** refers to the **Goal** of writing and solving inequalities to analyze production of aloe vera gel.

Analyze Instructions and Background

You may wish to provide support for students by reading and analyzing the instructions and background.

First, ask students to individually read the instructions beginning with "In this task, you are . . ." ***for context only***. Students will share with a partner their answers to the questions "What is the situation?" and "What do we need to find?" Note that these questions clarify the **Essential Question**: How can you use inequalities to solve a real-world problem? Provide the sentence stems below for additional language support. Circulate the room and assess student responses, providing appropriate feedback.

- This activity has to do with _____.
- I need to find _____.

Continue the class discussion as students read the remainder of page 1 and the **Understand Science Background** information on page 2. Ask students to read either independently or in groups and then answer the **Think about It** question. After reviewing these pages, students should understand the **Goal** of writing and solving inequalities to analyze production of aloe vera gel.

Now ask students to read or scan the first two pages again, this time ***for mathematical content***.

Ask students to work with a partner to answer the questions "What numbers appear in the problem?" and "What do those numbers represent (including the units)?" Ask students to share their answers aloud. Provide appropriate feedback.

- Some numbers I will work with are _____, _____, and _____.
- These numbers represent _____ and are measured in _____, which means _____.

Then ask students to pay close attention to the constraints: "What limitations are given in the problem?" Students should also be able to answer "How does the **Sample Plan** meet the conditions set by the constraints?"

- One constraint is that _____ must be _____.
- The **Sample Plan** meets the constraints because _____.

Walk Through the Sample Plan

The **Sample Plan** on page 1 provides students with a worked solution to the task. While reviewing the **Sample Plan** with your class, elicit participation as much as possible. You may also need to clarify the information in the images and tables on pages 1 and 2.

The **Essential Question** asks students to use inequalities to solve a real-world problem. Specifically, we need to grow two aloe vera plants, one after the other, to produce enough gel to fill two customer orders as quickly as possible. Consequently, the **Sample Plan** begins by selecting two of the orders from the table given on page 2. In this case, the **Sample Plan** selects order 5 for at least 880 grams of gel and order 6 for at least 1,048 grams of gel.

Order	Gel Needed
1	At least 376 grams
2	At least 460 grams
3	At least 544 grams
4	At least 796 grams
5	At least 880 grams
6	At least 1,048 grams
7	At least 1,216 grams
8	At least 1,468 grams

The constraints in the task require that the total growing time for two aloe vera plants to produce enough gel to fill the two customer orders be 24 months or less, with each plant providing the gel for one of the orders. Page 2 states that the aloe vera gel makes up 20% of the total leaf weight per plant. To find the number of months needed for the two plants to have leaves with the weight needed to produce 880 grams and 1,048 grams of gel, we use the table describing aloe vera plant growth, also on page 2.

Aloe Vera Plant Growth	
Month	**Total Leaf Weight per Plant (g)**
0	200
1	620
2	1,040
3	1,460

This table provides the total leaf weight per plant for the first three months of growth. A quick glance at the table shows that the total leaf weight increases by 420 grams per month. In **section A**, we use the pattern to write an expression to predict how much aloe vera gel a plant will produce after n months.

Month	Total Leaf Weight per Plant (g)	Gel Content (g) 0.20 × Total Leaf Weight per Plant (g)	Total Gel Weight per Plant (g)	
1	200	0.20 × 200	40	
2	620	0.20 × 620	124	+ 84 g
3	1,040	0.20 × 1,040	208	+ 84 g
4	1,460	0.20 × 1,460	292	+ 84 g

Because the gel is 20% of the total leaf weight, we can first multiply leaf weight by 0.20 to find the total gel produced each month. An analysis of the data shows that the initial gel weight of an aloe vera plant at month 0 is 40 grams, with an increase in gel weight of 84 grams per month. After n months, each plant will produce $40 + 84n$ grams of gel.

Next, we return to the task of filling order 5 for at least 880 grams of gel and order 6 for at least 1,048 grams of gel. We use the expression from **section A** to represent the relationship between the amount of gel produced per plant and the minimum amount of gel needed per order. Because ***at least*** describes a range of numbers that are greater than a given quantity as well as numbers that are equal to the given quantity or quantities, we write inequalities using the ≥ symbol rather than the > symbol.

$40 + 84n \geq 880$ $40 + 84n \geq 1{,}048$

First, we solve $40 + 84n \geq 880$ for n to find the number of months needed to produce *at least* 880 grams of aloe vera gel from one plant:

$40 + 84n \geq 880$	Write the inequality.
$40 + 84n - 40 \geq 880 - 40$	Subtract 40 from both sides.
$84n \geq 840$	Simplify.
$\frac{84n}{84} \geq \frac{840}{84}$	Divide both sides by 84.
$n \geq 10$	Simplify.

Next, we solve $40 + 84n \geq 1{,}048$ for n to find the number of months needed to produce at least 1,048 grams of gel from a second plant:

$40 + 84n \geq 1{,}048$	Write the inequality.
$40 + 84n - 40 \geq 1{,}048 - 40$	Subtract 40 from both sides.
$84n \geq 1{,}008$	Simplify.
$\frac{84n}{84} \geq \frac{1{,}008}{84}$	Divide both sides by 84.
$n \geq 12$	Simplify.

It will take 10 months or more to produce at least 880 grams of gel from one plant and 12 months or more to produce at least 1,048 grams of gel from another plant. The minimum total amount of time it would take for both plants to produce the required amount of gel for both orders is 10 + 12, or 22 months. This meets the constraint that the total growing time for two aloe vera plants to produce enough gel to fill the two customer orders be 24 months or less.

In the **Sample Plan**, we know that orders 5 and 6 can be filled with a total growing time of 24 months or less. When students develop their own plans in **section B**, they may initially choose two orders that cannot be filled in that time limit. Note that they can use the **Sample Plan** results as benchmarks to help them make initial choices in **section B**.

Our last step is to write a short description of our results, including the two orders that are filled, the total amount of gel that needs to be produced, and the minimum growing time for both plants:

> *To fill orders 5 and 6, I will need to produce at least 1,928 grams of aloe vera gel. The minimum total growing time for both plants will be 22 months.*

We have addressed the **Essential Question** of using inequalities to solve a real-world problem. This section of our task is complete!

Introduce Section A

Help students understand that the purpose of **section A** is to use data about the growth and weight of an aloe vera plant to identify the initial gel weight at 0 months and the increase in gel weight per month. Students then use these numbers to write an expression for the amount of gel a plant produces after *n* months and use the expression to write an inequality for the number of months it will take a plant to produce a given minimum quantity of gel. Students also explain the distinction between equations and inequalities.

Modifications: Students who need help with writing expressions may benefit from modeling the process with algebra tiles. You could allow students to work in pairs in **section A**. Also consider discussing student responses as a class or in small targeted groups before continuing to **section B**. The **Talk about It** prompt on page 3, which asks about alternative problem-solving strategies, could lead to a productive and informative class discussion.

Introduce Section B

Help students understand that the purpose of **section B** is to complete two plans for filling gel orders by writing inequalities using the ≥ symbol. They also distinguish between equations and inequalities in the context of the current task.

Modifications: Students who have difficulty completing **section B** may benefit from reviewing the **Sample Plan** on page 1. Consider having students practice their problem-solving skills in groups of four. Each student will complete only the first line of the inequalities under Plan 1. Then each student passes his or her page to the next student, who completes the second line in the inequality. Students continue solving and passing until both plans are complete, at which point the pages are returned to their owners for verification of the work.

Introduce Section C

Help students understand that the purpose of **section C** is to summarize and justify their results by writing a short description of their plans. They then connect their work to the overarching concept addressed in the **Essential Question** by explaining how they used inequalities to solve a real-world problem.

Students should use the **Conditional Language** as well as **Supporting Words** and **Major Words** in their responses.

Modifications: None.

Introduce Section D

Help students understand that the purpose of **section D** is to check the **Sample Plan** and their answers from **section C** by graphing their inequalities from the **Sample Plan** on a number line. Students choose three values from the number line to substitute into an equation to evaluate whether those values meet the requirements of the task. Students explain how checking their work with a number line justifies their solutions in the other sections of the task.

Modifications: If students have difficulty understanding the relationship between the inequalities and the equations that they use to check them, reinforce visual understanding by demonstrating the relationship with algebra tiles. You may also wish to discuss as a class any similarities or differences among student plans and solutions.

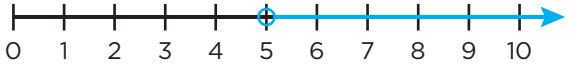
Watch Out: Common Misconceptions

Students may wonder why they cannot save time by growing both aloe vera plants simultaneously. Explain that in the real world, there are often limitations such as lack of space or other resources. Explore with students how removing the constraint of growing the plants one after the other would affect which orders they would choose to fill and how much gel they could produce.

Students may think that inequalities with the symbols > and ≥ are the same. Explain that when looking at the number line, the ≥ symbol is used to describe the range of numbers that are greater than a given quantity as well as numbers that are equal to the given quantity. Compare this with the definition of the > symbol, which is only used to describe the range of numbers that are greater than a given quantity.

Students often get confused about when to use a closed circle versus an open circle when graphing inequalities. Explain that solutions to both equations and inequalities are values that make the equation or inequality true. Solutions are graphed by marking a point on a number line. Values that do not make the equation or inequality true are not solutions and are thus left unmarked on the number line. On the graph of an equation, the endpoint is the only point that is marked, and it is marked with a closed circle. On the graph of an inequality, the value at the endpoint is a solution only for inequalities involving the ≥ or ≤ symbols, so it is only in these situations that the endpoint would be marked with a closed circle. The number line shows the graph of the inequality $x \geq 5$, with the endpoint 5 as a solution.

For inequalities involving the > or < symbol, the value of the endpoint is not a solution. Therefore, the endpoint is not marked and remains an open circle. The number line shows the graph of the inequality $x > 5$, with the endpoint 5 not included as a solution.



Another misconception is that the solutions of inequalities include only whole numbers. For example, in the above inequality $x > 5$, students may think that solutions begin at $x = 6$. Remind students that the solid line in the graph represents the fact that any point in the line is a solution, even values that are not whole numbers. Review the number line graph of $n \geq 10$ in **section D**, and point out that substituting any value on the graph for n will make the inequality true, including non-integer values such as $n = 11.5$.

Sample Rubric

Score	Criteria
3	Students accurately complete the table and expression in **section A** and then accurately answer the questions. In **section B**, they write and solve two inequalities each for two different plans and accurately explain their reasoning. Students' answers in **sections C** and **D** justify their plans with accurately applied math concepts. Students use conditional language in their explanations, along with mathematical language.
2	Students complete the table and expression in **section A** with one error at most. In **section B**, they write and solve two inequalities each for two plans and explain their reasoning with minor errors. Their answers in **sections C** and **D** justify their plans with math concepts and contain no more than one or two minor errors. Students use conditional language in their explanations, along with mathematical language.
1	Students complete the table and expression in **section A** with at least 50% accuracy. In **section B**, they write and solve inequalities and explain their reasoning with at least 50% accuracy. Their answers in **sections C** and **D** are mostly inaccurate statements that do not justify their plans and demonstrate a limited understanding of math concepts. Students use mathematical language in their explanations, but they do not use conditional language.
0	Students present a very limited or rudimentary response to the assignment. They complete the table and expression in **section A** with less than 50% accuracy, write and solve inequalities and explain their reasoning in **section B** with less than 50% accuracy, and include very general or incomplete answers in **sections C** and **D**. Students do not use conditional language in their explanations, and they do not use mathematical language.

STEM Activity Suggestions

STEM OBJECTIVE Explain the process of photosynthesis using the aloe vera plant as an example.

NGSS SCIENCE	SCIENCE AND ENGINEERING PRACTICE	MATHEMATICAL PRACTICE
NGSS MS-LS1-6	SEP6	MP1

1. **Build Background** The aloe vera plant has thick, succulent leaves that are filled with gel and latex. The gel can be applied to the skin as a remedy for burns and other skin irritations. Due to the increase in herbal, cosmetic, and superfood products that contain aloe vera, the plant has increased in popularity as a small-farm crop.

   Like other plants, aloe vera requires specific conditions to grow and to produce gel. To maximize gel production, farmers carefully plan irrigation of their fields, fertilize the soil, ensure adequate sunlight, and harvest the plant leaves in a way that allows new leaves to grow back.

   Ensuring adequate sunlight and water for aloe vera plants is necessary because this is what allows the plant to make its own food through a process called photosynthesis. Without these conditions, the aloe vera plant cannot continue growing and producing gel.

2. **Introduce the STEM Activity** In this activity, students will use the example of the aloe vera plant to explain the process of photosynthesis. Aloe vera uses a special form of photosynthesis that is an adaptation to hot climates. Emphasis should be on the cycling of matter and flow of energy in and out of the aloe vera plant in the photosynthesis process.

   Students will create a visual time line to illustrate the process of photosynthesis as an aloe vera plant grows. Encourage students to incorporate the expressions they wrote in the Application Task in their time lines and to extend their research to include other indicators of growth, such as the number of leaves per plant. Students should create their time lines in a format that can be shared with classmates. The time lines could include the use of number lines using inequalities.

3. **Guide Teams** Assist students as they create their time lines to explain the process of photosynthesis as it occurs in an aloe vera plant:

   - Because aloe vera plants often grow in warm climates, an adapted photosynthesis process enables plants' stomata to open at night and close during the day. In their time lines, students may wish to represent cyclic transitions from day to night and back again.
   - Aloe vera plants also have specialized structures for storing and transporting water. Students may want to include the movement of water over time in their explanation of photosynthesis in the aloe vera plant.

4. **Present Projects** If time allows, ask students to present their projects to the class. Students should clearly and accurately communicate the following:

   - the main structures within a plant that are involved in photosynthesis
   - the conditions necessary for photosynthesis to occur
   - the products and by-products of photosynthesis
   - how they decided to create a time line to illustrate photosynthesis
   - how their time line shows the flow of energy and matter in and out of the aloe vera plant over time

5. **Assess Results** Evaluate how effectively students explain the process of photosynthesis in the framework of a time line and using active voice and mathematical language (**NGSS MS-LS1-6, SEP6**). Check that students have made sense of the expressions, equations, and inequalities they use in their explanations and that they have provided reasonable interpretations of what the results of their equations and inequalities mean in the context of photosynthesis and plant growth (**MP1**).

Photosynthesis in aloe vera
http://bioweb.uwlax.edu/bio203/s2007/peteler_kari/food.htm

Research on aloe vera growth
https://hort.purdue.edu/newcrop/ncnu02/pdf/jasso-570.pdf

Medicines made from plants
https://www.thoughtco.com/drugs-and-medicine-made-from-plants-608413

APPLICATION TASK | **Analyze Aloe Vera Growth and Gel Production**

Name: _____

Goal
Write and solve inequalities to analyze production of aloe vera gel.

Language Objective
Use conditional and mathematical language to describe possible plans to solve real-world problems that involve inequalities.

Why Use Inequalities to Solve Real-World Problems?
Inequalities can help you solve problems when there is a range of possible solutions within constraints.

Essential Question **How can you use inequalities to solve a real-world problem?**

In this task, you are growing two **aloe vera** plants, one after the other, to **produce** enough **gel** to fill customers' **orders** as quickly as possible. You will develop two plans to fill the orders.

Constraints:

- Choose two of the given customer orders to fill.
- Each plant should provide gel for one of the orders.
- The total growing time for both plants should be 24 months or less.

SAMPLE PLAN

Order 5	Order 6
$40 + 84n \geq 880$	$40 + 84n \geq 1{,}048$
$40 + 84n - 40 \geq 880 - 40$	$40 + 84n - 40 \geq 1{,}048 - 40$
$84n \geq 840$	$84n \geq 1{,}008$
$\frac{84n}{84} \geq \frac{840}{84}$	$\frac{84n}{84} \geq \frac{1{,}008}{84}$
$n \geq 10$	$n \geq 12$

To fill orders 5 and 6, I will need to produce at least 1,928 grams of aloe vera gel. The minimum total growing time for both plants will be 22 months.

Examples of Medicinal Plants

Plant	Medicine Produced in Plant	Dosage (mg)
Willow tree	Aspirin • reduces pain and fever	300 to 650
Aloe vera	Aloin • used as a laxative	50 to 200
Ephedra	Ephedrine • reduces allergic reactions	30 to 60
Rose periwinkle	Vincristine • used to treat cancer	0.4 to 2
Nightshade	Hyoscine • treats motion sickness	0.4 to 0.8


Willow tree


Ephedra


Rose periwinkle

Medicinal plants produce drugs that can cure or treat human illnesses. Some medicinal plants, such as willow tree and aloe vera, have been used in traditional medicine for thousands of years. Other plants, such as the cancer-fighting rose periwinkle, have only recently been tested and used.

Like any medicine, drugs produced by plants should be used carefully. If too little is used, the drug may not be effective. If too much is used, the drug may be harmful. For this reason, doctors have determined a **dosage** for each medicine. Dosages describe the amount of the drug that is effective and safe to use. The table shows some medicinal plants along with their health benefits and dosages.

Did You Know? **Use of the aloe vera plant can be traced back 6,000 years to ancient Egypt.**

Background

Name: _____

Aloe vera is a popular medicinal plant used to treat a variety of health problems. The juice, or **latex**, of the aloe vera has been used for thousands of years as a laxative and for beauty care, though recent studies have found several harmful side effects if too much is used or consumed.

In addition to its juice, aloe vera also produces a **gel** within its leaves. This gel is safer to use than the juice and has become a common ingredient in health and beauty products. There are many uses of aloe vera gel:

- moisturizing skin and hair
- relieving burns
- relieving insect bites and scorpion stings
- killing mold, bacteria, and fungus
- relieving heartburn


Gel makes up 20% of the total leaf weight per plant!

In this task, you are growing two aloe vera plants, one after the other, to produce enough gel to fill customers' orders as quickly as possible. The tables below show how much gel each order needs and how much time it takes for your aloe vera plants to grow.

Order	Minimum Amount of Gel Needed (g)
1	376
2	460
3	544
4	796
5	880
6	1,048
7	1,216
8	1,468

Aloe Vera Plant Growth	
Month	**Total Leaf Weight per Plant (g)**
0	200
1	620
2	1,040
3	1,460

Think about It Some of the uses of aloe vera plants remain unproven by science. Why might it be difficult to prove whether a medicinal plant is effective?

Sample answer: Plants such as the aloe vera plant contain many different chemicals. These chemicals interact with our bodies in complex ways. In addition, it takes many studies—testing thousands of people—to produce enough valid and reliable evidence to prove that a medicine works effectively.

ACADEMIC VOCABULARY

Supporting Words

aloe vera: a plant native to the Middle East that is commonly used for its medicinal properties

dosage: the amount of a medicine or drug that is safe and effective to use

gel: a thick, jellylike substance

latex: a milky, white "juice" produced in some flowering plants

medicinal plant: any plant with healing properties that can be used to cure or relieve symptoms of an illness or disease

order: a request for something that someone wants to buy or use

produce: to make, provide, or cause something to happen

Example: The car manufacturer was able to produce 3.2 million cars this year.

Student Page Masters *(continued)*

A | Understand

Name: _____

Write an expression Use the information on page 2 to complete the table. Then write an **expression** for the gel content of an aloe vera plant after n months. Some values are entered for you.

Month	Total Leaf Weight per Plant (g)	Gel Content (g) 0.20 × Total Leaf Weight per Plant (g)	Total Gel Weight per Plant (g)
0	200	0.20 × 200	40
1	620	0.20 × 620	124
2	1,040	0.20 × 1,040	208
3	1,460	0.20 × 1,460	292

+ 84 g
+ 84 g
+ 84 g

Initial gel weight (at month 0): 40 g
Increase in gel weight per month: 84 g
Number of months: n
The expression for the gel content in grams after n months is 40 + 84 n.

Think about It Use the vocabulary from page 4 to answer the questions "How is an **equation** similar to an **inequality**?" and "How are they different?" Use conditional language in your response. Sample answer: Both equations and inequalities are a type of math sentence that compares expressions. If the comparison an equation, however, then the expressions must be equivalent; in an inequality the expressions could have different values. Furthermore, algebraic equations always have one solution, but an algebraic inequality could have multiple solutions—even infinite solutions.

Explain It If an order for aloe vera plant gel requires at least 880 grams of gel, how could you write an inequality to find how many months a plant will need to grow to produce enough gel? Sample answer: Because the expression 40 + 84n provides the amount in grams after n months and the amount needed is greater than or equal to 880 grams, I can write the inequality 40 + 84n ≥ 880 to find the number of months, n, the plant needs to grow to produce at least 880 grams of gel.

Talk about It Talk about how to solve this problem with a partner. Discuss how the sample solution in ***section A*** helps you meet the requirements of the task. Is there another way that you could solve the problem?

CONDITIONAL LANGUAGE

Conditional language is used to speculate about what could happen, what might have happened, or what you wish would happen. Use conditional language such as the following when writing or discussing possible growing times for your plants.

Examples:

If the aloe vera plant produces enough gel, **then you can use** it to relieve burns.

If the aloe vera plant had produced enough gel, **you would have used** it to relieve the burns.

If you want to relieve burns with an aloe vera plant, **it has to produce** enough gel.

B | Organize

Name: _____

Develop two plans filling two orders from the table on page 2. Write an inequality to find n, the minimum number of months each plant will need to grow to fill its order.

Constraints
- Fill different orders in each of your plans.
- Each plant should provide the gel for one of the orders.
- The total minimum growing time for both plants must be 24 months or less.

Plan 1

Order 3	Order 7
40 + 84 n ≥ 544	40 + 84 n ≥ 1,216
40 + 84 n − 40 ≥ 544 − 40	40 + 84 n − 40 ≥ 1,216 − 40
84 n ≥ 504	84 n ≥ 1,176
$\frac{84}{84} n \geq \frac{504}{84}$	$\frac{84}{84} n \geq \frac{1,176}{84}$
$n \geq 6$	$n \geq 14$

Plan 2

Order 1	Order 8
40 + 84 n ≥ 376	40 + 84 n ≥ 1,468
40 + 84 n − 40 ≥ 376 − 40	40 + 84 n − 40 ≥ 1,468 − 40
84 n ≥ 336	84 n ≥ 1,428
$\frac{84}{84} n \geq \frac{336}{84}$	$\frac{84}{84} n \geq \frac{1,428}{84}$
$n \geq 4$	$n \geq 17$

Explain It Why are inequalities used in this task instead of equations? How would using equations produce different results from using inequalities? Use conditional language in your response. Sample answer: Using an inequality indicates that plants can be allowed to grow for a longer time than the minimum times required by the orders, which is true in this case. If I used an equation, it would indicate that the gel must be removed at the exact time required by the order. This could make a difference in how schedules are made for filling orders.

MATHEMATICAL LANGUAGE

Major Words

equation: a mathematical sentence with an equal sign that shows that two expressions have equal values

Example:

expression: A mathematical statement that represents a number or quantity. Expressions may include numbers, variables, and operators. An expression does not include an equal symbol.

greater than: More than or bigger. The symbol > means greater than.

inequality: a mathematical sentence containing an inequality symbol, such as:

> > greater than
> < less than
> ≥ greater than or equal to
> ≤ less than or equal to

Examples: $a \geq b$
$3.1 > 3.04$
$x + y \leq 6$

less than: Smaller than or not as big. The symbol < means less than.

Name: _____

C | Solve

For each plan, write a short description that includes the following:
- the two filled orders
- the total amount of gel that needs to be produced
- the minimum growing time for both plants

Plan 1: Sample answer: To fill order 3 and order 7, I need to produce at least 1,760 grams of aloe vera gel. The minimum growing time for both plants is 20 months.

Plan 2: Sample answer: To fill orders 1 and 8, I need to produce at least 1,844 grams of aloe vera gel. The minimum growing time for both plants is 21 months.

Explain It Explain how you used inequalities to solve the production of aloe vera gel and find the time needed in your two plans. Sample answer: I wrote inequalities to find possible amounts of gel I could grow to fill customers' orders, and I solved them to determine the amount of time it would take to grow the plants.

D | Check

Check the solutions in the Sample Plan by graphing each inequality on a number line. Choose three points from each number line (the endpoint, a graphed point, and a nongraphed point), and evaluate whether those values fill the order. Then check your plans.

Order 5 $n \geq 10$

Order 6 $n \geq$ 12

Order	n	Amount of Gel Produced (g)	Does It Fill the Order?
5	10	$40 + 84n = 40 + 84\ (10) = 40 +$ 840 = 880	Yes
	11	$40 + 84n = 40 + 84\ (\ 11\ ) = 40 +$ 924 = 964	Yes
	9	$40 + 84n = 40 + 84\ (\ 9\ ) = 40 +$ 756 = 796	No
6	12	$40 + 84n = 40 + 84\ (\ 12\ ) = 40 +$ 1,008 = 1,048	Yes
	13	$40 + 84n = 40 + 84\ (\ 13\ ) = 40 +$ 1,092 = 1,132	Yes
	10	$40 + 84n = 40 + 84\ (\ 10\ ) = 40 +$ 840 = 880	No

Minimum total growing time of both plants: 10 + 12 = 22 months

Minimum total amount of gel produced: 880 + 1,048 = 1,928 grams

Explain It Explain how the number lines show whether the Sample Plan is correct. How can your work in ***section D*** justify your solution in ***section C***? Sample answer: The endpoint of each number line shows the minimum gel and time to fill the order. Graphed points fill the orders, but nongraphed points do not. I could similarly justify my solution.

CONNECT TO SCIENCE

Through the process of photosynthesis, green plants use sunlight to make food from carbon dioxide and water.

How do you think sunlight would affect the growth of an aloe vera plant?
Sample answer: Because aloe vera plants are green plants, they would need sufficient sunlight to keep growing.

If an aloe vera plant is not growing, what are some possible steps you could take to help it grow?
Sample answer: I could research best conditions for growing aloe vera plants. If the plant does not seem to be getting enough sunlight, for example, I could move it near a sunny window. If it seems too dry or wet, I could change the watering schedule.

Extend Suppose that you have found a way to increase the gel production rate of your aloe vera plants from 20% to 30% of the total leaf weight. Develop a third plan for the new rate of growth. If the total leaf weight per plant at month 0 stays at 200 grams, what expression models the total gel weight per plant after n months given the new growth rate? Explain your reasoning.
Sample answer: $60 + 126n$. If the gel production increases to 30% of the total leaf weight, the new starting gel weight is 0.3×200, or 60 g. The new growth rate is 0.3×420, or 126 grams per month.

imagine Math

Analyze Aloe Vera Growth and Gel Production
Expressions and Equations | Grade 7

