National Aeronautics and Space Administration

LAUNCH INTO MATH

Common Core Standards

Exercise 1: 6.RP.A.2; 6.RP.A.3

With this exercise, students will:

- Practice writing rates in a/b form and using rate language in the context of a ratio relationship.
- Convert rates using different units of time.
- Use ratio/rate reasoning to calculate the time it would take to get to the Moon at various speeds.

Exercise 2: 6.G.A.2

With this exercise, students will:

- Find the edge lengths of a right rectangular prism using unit cubes.
- Calculate the volume of a right rectangular prism using the formula.

Exercise 3: 6.SP.B.5.B; 6.SP.B.5.C

With this exercise, students will:

- Find the median of a solar activity data set.
- Use the median to determine the first and third quartile of the solar activity data set.
- Calculate the interquartile range of the solar activity data.

Exercise 4: 6.EE.B.5; 6.EE.B.8; 6.RP.A.3

With this exercise, students will:

- Calculate the minimum distance the SLS will travel at a given speed and time interval.
- Calculate the maximum distance the SLS will travel at a given speed and time interval.
- Write an inequality of the form $x > a$ or $x < b$ to represent the range of distances the SLS travels at a given speed and time interval.

Exercise 5: 6.GA.1; 6.RP.A.3

With this exercise, students will:

- Find the area of a triangular region of the lunar surface.
- Calculate the ratio of the number of craters in the triangular region to the region's area.
- Determine the approximate age of this region by using a table correlating number of craters per square kilometer to the age of the lunar surface.

Exercise 6: 6.RP.A.3.C

With this exercise, students will:

- Use a formula to calculate the percent rehydration of a food sample with a defined dehydrated mass.
- Determine the amount of water necessary for a defined dehydrated mass to achieve a certain percentage of rehydration.

Exercise 7: 7.G.B.4; 8.NS.A.2

With this exercise, students will:

- Calculate the area of Orion's target landing zone (a semicircle) using two different approximations of pi.
- Find the difference of the two areas.

Exercise 8: 6.G.A.3; 8.G.B.8

With this exercise, students will:

- Calculate the distance between two points using the application of the Pythagorean Theorem.
- Determine whether the Lunar Terrain Vehicle will be able to complete its route on a single charge.

Exercise 1

Ratios, Rates, and Units

The Artemis missions are all about a human-robotic return to the Moon. The journey will take teamwork, imagination, and — you guessed it — a lot of math! The exercise below explores the duration of the voyage ahead.

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

How long will it take to get to the Moon?

During the Artemis missions, the Orion spacecraft will travel about 250,000 miles (~402,350 kilometers) to the Moon in roughly 4 days.

Problem 1

Chances are, you don't have a rocket parked in your driveway, and you probably don't ride a space capsule to school. **So how many days would it take for a bus or a car to get to the Moon?** Use the measurements below in your solution. Round your answer to the nearest whole number.

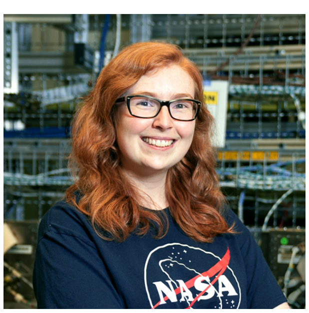
Approximate distance the Orion spacecraft will travel to the Moon: 250,000 miles
Speed of the car/bus: 60 miles per hour
Hours in a day: 24

Problem 2

Maybe you missed the bus, or you couldn't hitch a ride. Or maybe you're just in the mood for a stroll. **How many days would it take to walk to the Moon? How many years?** Round the number of days to the nearest whole number and the number of years to the nearest tenth.

Approximate distance Orion will travel to the Moon: 250,000 miles
Average walking speed: 3 miles per hour
Hours in a day: 24
Days in a year: 365

There are no traffic lights in space. But there is a speed limit! The speed of light, which is 670,616,629 miles per hour, is the rate at which photons (particles of light) move.



Meet the Artemis Team

Mathematicians and engineers at NASA are working hard to make sure the journey to the Moon is safe. Take Hannah Hopkins for example. Hannah is one of the software engineers of the Space Launch System, the rocket that will launch Orion to the Moon. Using a computer program, Hannah can simulate the launch and flight of the SLS in the event that something goes wrong.

Read more about Hannah's work on the SLS at https://www.nasa.gov/people/i-am-building-sls-hannah-hopkins/.

Solution

Exercise 1: Ratios, Rates, and Units

How long will it take to get to the Moon?

Problem 1

How many days would it take for a bus or a car to get to the Moon?
Round your answer to the nearest whole number.

Measurements and formulas:

Approximate distance the Orion spacecraft will travel to the Moon: 250,000 miles
Speed of the car/bus: 60 miles per hour
Hours in a day: 24

Solution:

Hours to the Moon at 60 mph: 250,000 miles $\bullet \frac{\text{1 hour}}{\text{60 miles}}$ = 4,166.666 hours

Days to the Moon at 60 mph: 4,166.66 hours $\bullet \frac{\text{1 day}}{\text{24 hours}}$
= 173.611 days ≈ 174 days

Final solution: It would take about 174 days to drive to the Moon. That's about 6 months!

Problem 2

How many days would it take to walk to the Moon? How many years? Round the number of days to the nearest whole number and the number of years to the nearest tenth.

Measurements and formulas:

Approximate distance Orion will travel to the Moon: 250,000 miles
Average walking speed: 3 miles per hour
Hours in a day: 24
Days in a year: 365

Solution:

Hours to the Moon at 3 mph: 250,000 miles $\cdot \frac{\text{1 hour}}{\text{3 miles}}$ = 83,333.333 hours

Days to the Moon at 3 mph: 83,333.333 hours $\cdot \frac{\text{1 day}}{\text{24 hours}}$
= 3,472.222 days ≈ 3,472 days

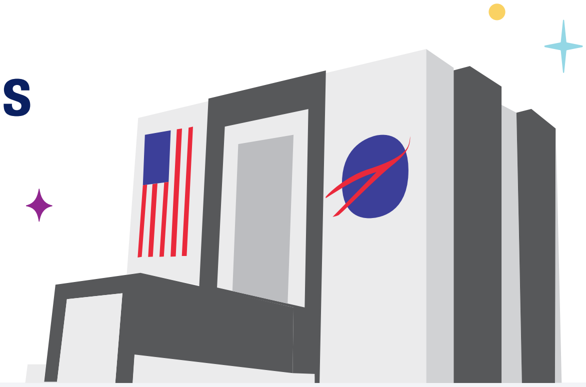
Years to the Moon at 3 mph: 3,472.222 days $\cdot \frac{\text{1 year}}{\text{365 days}}$
= 9.513 years ≈ 9.5 years

Final solution: It would take about 3,472 days to walk to the Moon, which is about 9.5 years.

Exercise 2

Volume and Geometric Solids

It takes a lot of space to go to space! In the exercise below, explore how volume is important to the construction and assembly of the SLS (Space Launch System) rocket and the Orion spacecraft.



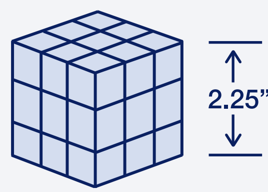
Volume of the Vehicle Assembly Building

Based out of NASA's Kennedy Space Center in Florida, **Exploration Ground Systems (EGS)** is the program that will prepare the SLS and the Orion spacecraft for launch. The **Vehicle Assembly Building** is quite literally a huge part of that process. With its 525-foot-tall ceiling, the Vehicle Assembly Building is one of the only buildings in the world where the SLS and Orion can be assembled.

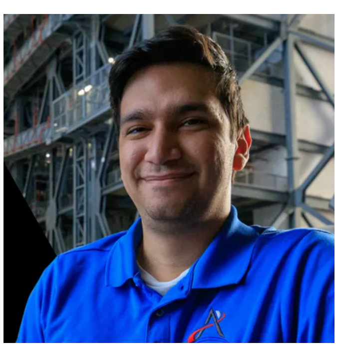
Problem 1

Let's say you want to turn one of the world's largest buildings into the world's largest stack of puzzle cubes. **If you were stacking the cubes on top of each other, approximately how many puzzle cubes would it take to fill the high bay of the Vehicle Assembly Building?** (The high bay is the super tall part of the Vehicle Assembly Building.) Use the formulas and measurements below to find your estimate. Round your answer to the nearest million.

Height of the high bay: 525 feet
Length of the high bay: 440 feet
Width of the high bay: 518 feet
Length/width/height of a puzzle cube: 2.25 inches
Inches in a foot: 12
Formula for the volume of a rectangular prism:
length · width · height



Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.



Meet the Artemis Team

Getting to the Moon is a team effort, and no one knows that better than Abdiel Santos-Galindo. Abdiel is a ground systems integration engineer for EGS. He spends most of his time at the Vehicle Assembly Building and the Rotation, Processing, and Surge Facility, where he ensures that the ground systems technology for the SLS and Orion are working properly.

Read more about Abdiel's work at https://www.nasa.gov/humans-in-space/i-am-artemis-abdiel-santos-galindo/.

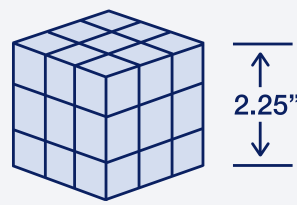
Solution

Exercise 2: Volume and Geometric Solids

Volume of the Vehicle Assembly Building

Problem 1

If you are stacking puzzle cubes on top of each other, approximately how many will it take to fill up the high bay of the Vehicle Assembly Building? Round your answer to the nearest million.



Measurements and formulas:

Height of the high bay: 525 feet
Length of the high bay: 440 feet
Width of the high bay: 518 feet
Length/width/height of a puzzle cube: 2.25 inches
Inches in a foot: 12

Solution:

Length/width/height of a puzzle cube in feet: $2.25 \text{ inches} \cdot \frac{1 \text{ foot}}{12 \text{ inches}} = 0.1875 \text{ feet}$

Length of the stack: $\frac{\text{length of the high bay}}{\text{side of puzzle cube}} = \frac{440 \text{ feet}}{0.1875 \text{ feet}} = 2{,}346.67 \approx 2{,}346$ puzzle cubes

Width of the stack: $\frac{\text{width of the high bay}}{\text{side of puzzle cube}} = \frac{518 \text{ feet}}{0.1875 \text{ feet}} = 2{,}762.67 \approx 2{,}762$ puzzle cubes

Height of the stack: $\frac{\text{height of the high bay}}{\text{side of puzzle cube}} = \frac{525 \text{ feet}}{0.1875 \text{ feet}} = 2{,}800$ puzzle cubes

Total number of cubes: length • width • height = 2,346 • 2,762 • 2,800 = 18,143,025,600
≈ 18,143,000,000 puzzle cubes

Final solution: It will take a stack of about 18,143,000,000 puzzle cubes to fill the high bay of the Vehicle Assembly Building.

Exercise 3

Medians and Interquartile Ranges

Space radiation (energy that is emitted in the form of rays, electromagnetic waves, and/or energetic particles) is a pretty big deal. Overexposure to radiation can increase the risk of diseases like cancer. In order to study radiation levels in deep space, NASA sent Helga and Zohar, two radiation-detecting phantoms, or stand-ins for humans, on the Artemis I mission. In the exercise below, discover how space radiation relates to solar activity data.

The Radiation Situation

Space meteorologists monitor radiation from the Sun to ensure safety on all of NASA's missions. The Sun's activity increases and decreases in an 11-year solar cycle. One way to track this cycle is to count sunspots. Sunspots are areas on the Sun's surface with particularly strong magnetic fields where energy can be stored. When sunspots interact with each other, there can be an explosion of this energy! During these explosions, called solar flares, the Sun emits energetic particles into space.

Solar Cycle 24

As a budding space meteorologist, you are studying the 24th recorded solar cycle, which began in December 2008 and ended in December 2019. The data set below shows the number of sunspots observed during each June in the 11-year cycle.

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
# of Sunspots	6.3	18.8	56.1	92.0	76.7	102.9	66.5	20.5	19.2	15.6	1.2

Problem 1

What is the median (second quartile) of the Solar Cycle 24 data set?

Problem 2

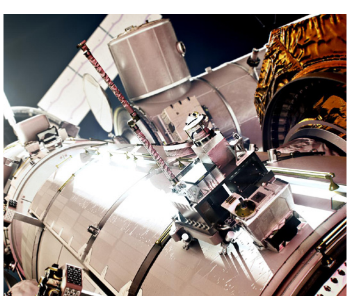
What are the first and third quartiles of the Solar Cycle 24 data set?

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

Problem 3

What is the interquartile range (IQR) of the data set? (The IQR measures the middle 50% of the data.)

The first quartile (Q_1) is the median of all the numbers to the left of the second quartile (Q_2). The third quartile (Q_3) is the median of the numbers to the right of Q_2. Subtract Q_1 from Q_3 and you've got the IQR!



Meet the Artemis Team

NASA Gateway is a small multipurpose space station that will support lunar surface missions, science in lunar orbit, and human exploration further into the cosmos. HERMES (Heliophysics Environmental and Radiation Measurement Experiment Suite) is a space weather instrument package that will be one of the first research missions to fly on Gateway.

Learn more about the HERMES mission at https://science.nasa.gov/mission/hermes/.

Solution

Exercise 3: Medians and Interquartile Ranges

Solar Cycle 24

Problem 1

What is the median (second quartile) of the Solar Cycle 24 data set?

Solution:

To determine the median, or second quartile, we first sort the data from smallest to largest:

1.2, 6.3, 15.6, 18.8, 19.2, 20.5, 56.1, 66.5, 76.7, 92.0, 102.9

The median is the middle number in the sorted data:

~~1.2, 6.3, 15.6, 18.8, 19.2~~, **20.5**, ~~56.1, 66.5, 76.7, 92.0, 102.9~~

Final solution: The median is 20.5.

Problem 2

What are the first and third quartiles of the Solar Cycle 24 data set?

Solution:

We already know that the second quartile, or Q_2, of the Solar Cycle 24 data set is 20.5. We determine the first quartile, or Q_1, by finding the median of all the values to the left of Q_2 :

~~1.2, 6.3,~~ **15.6**, ~~18.8, 19.2,~~ | **20.5** | , 56.1, 66.5, 76.7, 92.0, 102.9

To determine the third quartile, or Q_3, find the median of all the values to the right of Q_2,:

1.2, 6.3, 15.6, 18.8, 19.2, | **20.5** | , ~~56.1, 66.5,~~ **76.7**, ~~92.0, 102.9~~

Final solution: The first quartile is 15.6 and the third quartile is 76.7.

Problem 3

Calculate the interquartile range (IQR) of the Solar Cycle 24 data set.

Solution:

Now that we have Q_1 and Q_3, we calculate the IQR:

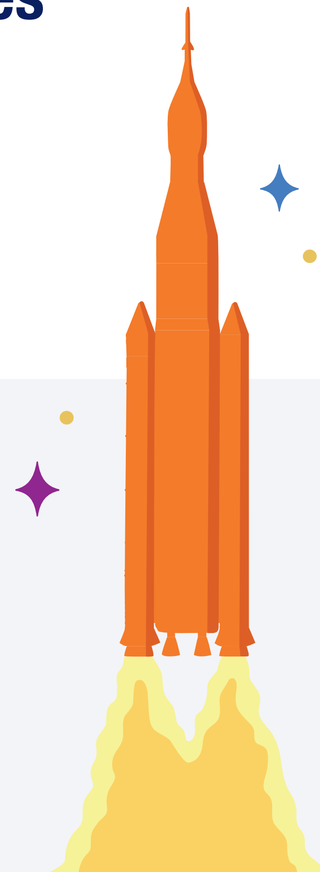
$$IQR = Q_3 - Q_1 = 76.6 - 15.6 = 61.1$$

Final solution: The interquartile range for the Solar Cycle 24 set is 61.1. This means that the amount of spread in the middle half of the data set is 61.1 sunspots.

Exercise 4

Maximums, Minimums, and Inequalities

The first 8½ minutes of flight are pretty busy for the SLS (Space Launch System) rocket! Within 10 seconds of launch, the rocket clears the launch tower at NASA's Kennedy Space Center in Florida. Within 2 minutes, after burning through 3 million lbs. of propellant, the boosters separate from the rocket and fall toward the Atlantic Ocean. After 8½ minutes, the SLS core stage separates from the Orion spacecraft and falls toward the Pacific Ocean. At this point, Orion is orbiting Earth and preparing for the next big push—this time, to the Moon!



In the Blink of an Eye

When it comes to rockets, a lot can happen in 8½ minutes. But what can the SLS do in practically no time at all – not a minute, not even a second, but a fraction of a second?

Problem 1

It takes between 100 and 400 milliseconds to blink.
The travel speed of the SLS is about 24,500 miles per hour.
At this speed, what is the maximum distance the SLS travels in the blink of an eye? What is the minimum distance? Round your answers to the nearest hundredth mile.

Travel speed of the SLS: 24,500 miles per hour
Minutes in an hour: 60
Seconds in a minute: 60
Milliseconds in a second: 1,000
Time it takes to blink: 100 to 400 milliseconds

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

Problem 2

Let’s say the SLS is moving at travel speed. **What inequality represents D, the range of distances the SLS covers in the blink of an eye?**

Meet the Artemis Team

Growing up in Huntsville, Alabama, Gwen Artis loved all things math, science, and space. Today, Gwen is a senior systems engineer for the SLS’s launch vehicle stage adapter (the part that encloses the Interim Cryogenic Propulsion Stage, which will propel the rocket once it’s in Earth’s orbit).

Learn more about Gwen’s work at https://www.nasa.gov/humans-in-space/i-am-artemis-gwen-artis/.

Solution

Exercise 4: Maximums, Minimums, and Inequalities

In the Blink of an Eye

Problem 1

It takes between 100 and 400 milliseconds to blink. The travel speed of the SLS is about 24,500 miles per hour. At this speed, what is the maximum distance the SLS travels in the blink of an eye? What is the minimum distance? Round your answers to the nearest hundredth mile.

Measurements and formulas:

Travel speed of the SLS: 24,500 miles per hour
Minutes in an hour: 60
Seconds in a minute: 60
Milliseconds in a second: 1,000
Time it takes to blink: 100 to 400 milliseconds

Solution:

Travel speed in minutes: $\frac{24{,}500 \text{ miles}}{1 \text{ hour}} \cdot \frac{1 \text{ hour}}{60 \text{ minutes}} \approx 408.333$ miles per minute

Travel speed in seconds: $\frac{408.333 \text{ miles}}{1 \text{ minute}} \cdot \frac{1 \text{ minute}}{60 \text{ seconds}} \approx 6.806$ miles per second

Travel speed in milliseconds: $\frac{6.806 \text{ miles}}{1 \text{ second}} \cdot \frac{1 \text{ second}}{1{,}000 \text{ milliseconds}} \approx 0.006806$ miles per millisecond

Distance traveled in 100 milliseconds: $\frac{0.006806 \text{ miles}}{1 \text{ millisecond}} \cdot 100 \text{ milliseconds} \approx 0.68$ miles

Distance traveled in 400 milliseconds: $\frac{0.006806 \text{ miles}}{1 \text{ millisecond}} \cdot 400 \text{ milliseconds} \approx 2.72$ miles

Final solution: At travel speed, the SLS travels a minimum distance of 0.68 miles in the blink of an eye. It travels a maximum distance of 2.72 miles in the blink of an eye.

Problem 2

Let's say the SLS is moving at travel speed. **What inequality represents D, the range of distances the SLS covers in the blink of an eye?**

Measurements and formulas:

Minimum distance: 0.68 miles
Maximum distance: 2.72 miles

Solution:

Since the SLS travels a maximum distance of 2.72 miles in blink of an eye, we know that $D \leq 2.72$.
Since the SLS travels a minimum distance of 0.68 miles in blink of an eye, we know that $D \geq 0.68$.
Since $D \leq 2.72$ and $D \geq 0.68$, then $0.68 \leq D \leq 2.72$.

Final solution: The range of distances the SLS covers in the blink of an eye at travel speed is represented by the inequality: 0.68 miles ≤ D ≤ 2.72 miles.

Exercise 5

Area and Frequency

CubeSats are research satellites that gather information, test out new technologies in space, and can fit inside a shoe box! During Artemis I, ten of these tiny-but-mighty satellites flew with the SLS (Space Launch System) rocket. In the exercise below, learn how CubeSats (and math!) are important to lunar science.

Lean, Mean, Imaging Machines

Three of the ten CubeSats hitching a ride on the SLS mapped or captured images of the lunar surface. These maps and images will help us understand where ice and hydrogen are located on the Moon and will also help NASA determine future landing sites for crewed Artemis missions.

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

Dating a Lunar Surface

Dating the lunar surface doesn't mean sending it flowers and chocolates. It means estimating the age of various sections of the surface. One way to do this is by looking at the number of craters in a specific section—the older the section, the longer it's been exposed to asteroids and meteors, and the more craters it will have.

Problem 1

Let's say you are looking at a triangular region of the lunar surface. This section of the lunar surface has a base of 14 kilometers and a height of 45 kilometers. **What is the area of this section of the lunar surface?**

Base of the triangle: 14 kilometers

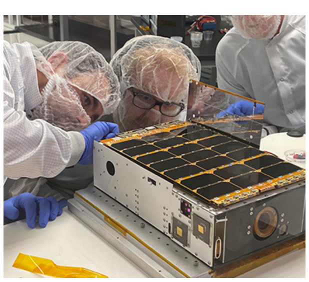
Height of the triangle: 45 kilometers

Formula for the area of a triangle: $\frac{\text{base} \cdot \text{height}}{2}$

Problem 2

Let's say you spot 24 craters in the triangular region. **What is the number of craters per square kilometer? Based on the table below, approximately how old is this section of the lunar surface?**

Number of craters per square kilometer	0.0008	0.008	0.08	0.8	8.0	80.0	800.0
Estimated age of lunar surface (years)	1,000	10,000	100,000	1 million	10 million	100 million	1 billion



Meet the Artemis Team

A whole team of students from Morehead State University are behind the Lunar IceCube CubeSat. During Artemis I, this CubeSat navigated the surface of the Moon to map out the distribution of water.

Read more about the team's work at https://www.nasa.gov/missions/artemis/artemis-1/lunar-icecube-mission-to-locate-study-resources-needed-for-sustained-presence-on-moon/.

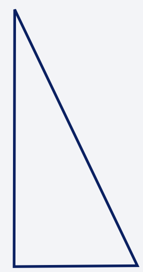
Solution

Exercise 5: Area and Frequency

Dating a Lunar Surface

Problem 1

Let's say you are looking at a triangular region of the lunar surface. This section of the lunar surface has a base of 14 kilometers and a height of 45 kilometers. **What is the area of this section of the lunar surface?**



Measurements and formulas:

Base of the triangle: 14 kilometers

Height of the triangle: 45 kilometers

Formula for the area of a triangle: $\frac{\text{base} \cdot \text{height}}{2}$

Solution:

Area of the triangular region: $\frac{\text{base} \cdot \text{height}}{2} = \frac{14\text{ km} \cdot 45\text{ km}}{2} = 315\text{ km}^2$

Final solution: The area is 315 square kilometers.

Problem 2

Let's say you spot 24 craters in the triangular region. **What is the number of craters per square kilometer? Based on the table below, approximately how old is this section of the lunar surface?**

Table:

Number of craters per square kilometer	0.0008	0.008	0.08	0.8	8.0	80.0	800.0
Estimated age of lunar surface (years)	1,000	10,000	100,000	1 million	10 million	100 million	1 billion

Solution:

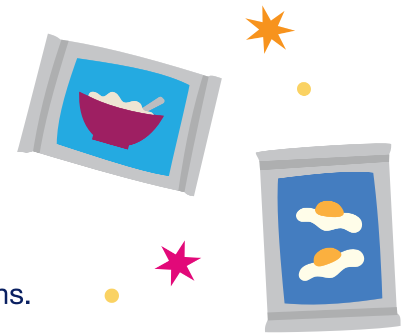
Number of craters per square kilometer: $\frac{\text{Number of craters}}{\text{Number of square kilometers}} = \frac{24}{315}$

$= 0.07619 \approx 0.08$ craters per square kilometer

Final solution: This section of the lunar surface has about 0.08 craters per square kilometer, which makes it approximately 100,000 years old.

Exercise 6

Percentages



From engineers to computer scientists to statisticians, the Artemis program relies on math whizzes of all kinds. In the exercise below, learn how NASA's food scientists use percentages to prepare food for crewed Artemis missions.

Food For Thought

Space food needs to be more than just tasty—it also needs to take up minimal space and provide enough calories to keep astronauts strong and healthy. (Basically, it's one big math problem.) One way to dramatically decrease the mass of food to prepare it for space travel is through **dehydration**, which means removing the moisture from something. Once in space, astronauts rehydrate their food before eating it.

Breakfast of Champions

Problem 1

Let's say you are rehydrating eggs for a super scrumptious space breakfast. The mass of the dehydrated eggs is 2.2 ounces (oz). **If you add 1.8 oz of water, what is the percentage of rehydration?**

Dehydrated mass: 2.2 oz

Gain in mass: 1.8 oz

% Rehydration: $\frac{\text{gain in mass + dehydrated mass}}{\text{dehydrated mass}} \cdot 100$

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

Problem 2

Let's say you want some delicious oatmeal to go with your eggs, and you like your oatmeal a little thick. **For 28 grams of oatmeal to absorb 90% of its mass in water, how much water must be added?**

Dehydrated mass: 28 grams

% Rehydration: 190%

Meet the Artemis Team

What's on the menu? Just ask Xulei Wu, a senior food scientist at NASA's Johnson Space Center. Xulei finds creative ways to process food for space travel—including 3D-printing it!

Read more about how space food is created at https://www.nasa.gov/directorates/esdmd/hhp/space-food-systems/.

Solution

Exercise 6: Percentages

Breakfast of Champions

Problem 1

Let's say you are rehydrating eggs for a super scrumptious space breakfast. The mass of the dehydrated eggs is 2.2 ounces (oz). **If you add 1.8 oz of water, what is the percentage of rehydration?**

Measurements and formulas:

Dehydrated mass: 2.2 oz

Gain in mass: 1.8 oz

$$\% \text{ Rehydration: } \frac{\text{gain in mass + dehydrated mass}}{\text{dehydrated mass}} \cdot 100$$

Solution:

$$\% \text{ Rehydration: } \frac{1.8 \text{ oz} + 2.2 \text{ oz}}{2.2 \text{ oz}} \cdot 100 = \frac{4 \text{ oz}}{2.2 \text{ oz}} \cdot 100 \approx 1.82 \cdot 100 = 182\%$$

Final solution: If you add 1.8 oz of water to the dehydrated eggs, they will be 82% rehydrated.

Problem 2

Let's say you want some delicious oatmeal to go with your eggs, and you like your oatmeal a little thick. **For 28 grams of oatmeal to absorb 90% of its mass in water, how much water must be added?**

Solution:

$$\% \text{ Rehydration: } 190 = \frac{\text{gain in mass + 28 grams}}{\text{28 grams}} \cdot 100$$

$$\longrightarrow \frac{190}{100} = 1.90 = \frac{\text{gain in mass + 28 grams}}{\text{28 grams}}$$

$\longrightarrow$ 1.90 • 28 grams = 53.2 grams = grain in mass + 28 grams

$\longrightarrow$ 53.2 grams - 28 grams = 25.2 grams = gain in mass

Final solution: For the oatmeal to absorb 90% of its mass in water, 25.2 grams of water must be added.

Exercise 7

Approximations of Pi

The number pi may be small, but it is a big deal when it comes to space travel. In the exercise below, use approximations of pi to calculate the area of the Orion spacecraft's weather alternate landing zone.

Pieces of Pi

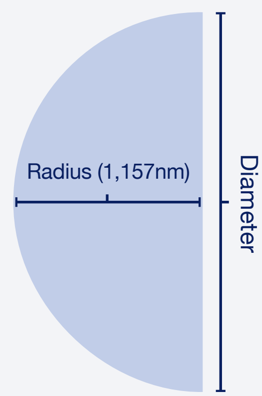
Pi (represented by the symbol π) is equal to the ratio of a circle's circumference to its diameter. Pi is an **irrational number**, which means it can't be written as a fraction and has an infinite number of decimals. You can approximate pi with two decimals ($\pi \approx 3.14$). You can also approximate pi with fifteen decimals ($\pi \approx 3.141592653589793$), which is what NASA uses for its most precise flight calculations. You can even approximate pi with 68.2 trillion decimals, as a supercomputer did in 2021. The possibilities are literally endless!

Approximating the Weather Alternate Landing Zone

Upon its reentry to Earth, Orion will splashdown in the Pacific Ocean. Ideally, the spacecraft will land about 43 nautical miles (nm) off the coast of San Diego, California. However, in the event of bad weather, Orion could splashdown up to 1,200 nm from land!

Problem 1

Orion's weather alternate landing zone is a semicircle in the Pacific Ocean with a radius of about 1,157 nm. This area ensures that Orion will not splashdown into dangerous weather systems. **What is the area of the weather alternate landing zone if you approximate pi with two decimals? ($\pi \approx 3.14$). What is the area of the weather alternate landing zone if you approximate pi with fifteen decimals? ($\pi \approx 3.141592653589793$).** Round your answers to the nearest whole number.



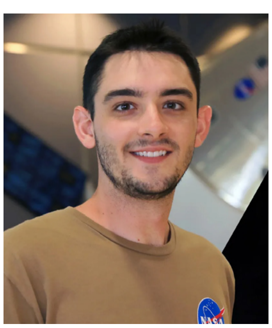
Radius of the semicircle: 1,157 nm

Formula for the area of a semicircle: $\dfrac{\pi \cdot \text{radius}^2}{2} = \dfrac{\pi \cdot \text{radius} \cdot \text{radius}}{2}$

Problem 2

What is the difference in the areas of the weather alternate landing zones in problem 1?

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.



Meet the Artemis Team

In 2009, Taylor Hose was a ninth grader whose aerospace engineering project landed him at the West Virginia state science fair. Today, Taylor is a Flight Vehicle Processing Technician at NASA's Kennedy Space Center in Florida. When Orion splashed into the Pacific Ocean, Taylor was part of the recovery team that brought Orion back to shore.

Read more about Taylor's work at https://www.nasa.gov/humans-in-space/exploration-ground-systems/orion-recovery/.

Solution

Exercise 7: Approximations of Pi

Approximating the Weather Alternate Landing Zone

Problem 1

Orion's weather alternate landing zone is a semicircle in the Pacific Ocean with a radius of about 1,157 nm. **What is the area of the weather alternate landing zone if you approximate pi with two decimals? ($\pi \approx 3.14$). What is the area of the weather alternate landing zone if you approximate pi with fifteen decimals? ($\pi \approx 3.141592653589793$).** Round your answers to the nearest whole number.

Teacher tip: If students do not have access to a calculator capable of displaying this approximation of pi, consider allowing them to use an internet calculator.

Measurements and formulas:

Radius of the semicircle: 1,157 nm

Formula for the area of a semicircle: $\frac{\pi \cdot \text{radius}^2}{2} = \frac{\pi \cdot \text{radius} \cdot \text{radius}}{2}$

Solution:

Weather alternate landing zone area ($\pi \approx 3.14$): $\frac{\pi \cdot \text{radius}^2}{2} = \frac{3.14 \cdot (1{,}157 \text{ nm})^2}{2} =$

$\longrightarrow \frac{3.14 \cdot (1{,}338{,}649 \text{ nm})^2}{2} = \frac{4{,}203{,}357.86 \text{ nm}^2}{2} = 2{,}101{,}678.93 \text{ nm}^2 \approx 2{,}101{,}679 \text{ nm}^2$

Weather alternate landing zone area ($\pi \approx 3.141592653589793$): $\frac{\pi \cdot \text{radius}^2}{2} =$

$\longrightarrow \frac{3.141592653589793 \cdot (1{,}157 \text{ nm})^2}{2} = \frac{3.141592653589793 \cdot 1{,}338{,}649 \text{ nm}^2}{2} = \frac{4{,}205{,}489.864 \text{ nm}^2}{2}$

$= 2{,}102{,}744.932 \text{ nm}^2 \approx 2{,}102{,}745 \text{ nm}^2$

Final solution: When $\pi \approx 3.14$ the area of the weather alternate landing zone is about 2,101,679 square nautical miles. When $\pi \approx 3.141592653589793$ the area of the weather alternate landing zone is about 2,102,745 square nautical miles.

Problem 2

What is the difference in the areas of the weather alternate landing zones in problem 1?

Measurements and formulas:

Weather alternate landing zone area ($\pi \approx 3.14$): 2,101,679 nm^2

Weather alternate landing zone area ($\pi \approx 3.141592653589793$): 2,102,745 nm^2

Solution:

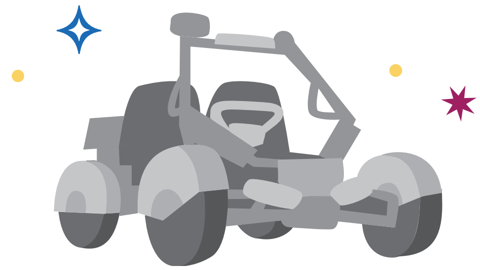
Difference in area: $2{,}102{,}745 \text{ nm}^2 - 2{,}101{,}679 \text{ nm}^2 = 1{,}066 \text{ nm}^2$

Final solution: The difference in area is 1,066 square nautical miles.

Exercise 8

Coordinate Planes

Road trip time! In the exercise below, learn how astronauts on future Artemis missions will use the Lunar Terrain Vehicle (LTV) to explore the surface of the Moon.



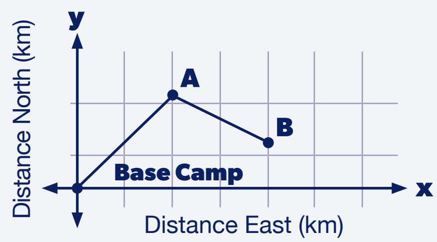
A Bumpy Ride

During future Artemis missions, astronauts will need some pretty cool wheels to explore and conduct experiments at the lunar South Pole. That's where the LTV comes in. The LTV will be a rover with enough space for two astronauts in spacesuits to ride. It will be specially designed to handle the Moon's rocky, crater-filled landscape.

Feel free to use a calculator for this exercise ... unless you really love long multiplication and division.

Just Your Average, Normal Lunar Road Trip

Suppose you are planning a road trip in the LTV and that you've mapped out your route on a two-dimensional coordinate plane. The first leg of the trip will take you northeast from the base camp to destination A. The second leg of the trip will take you southeast from destination A to destination B.



Problem 1

What is the distance in kilometers from the base camp (0,0) to destination A (2,2)? What is the distance in kilometers from destination A to destination B (1,4)? Round your answer to the nearest hundredth.

Formula for the distance between two points: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Problem 2

To conserve the LTV's battery, Mission Control has requested that the LTV travels less than 20 kilometers in a single day. **Given this restriction, will the LTV be able to make it back to the base camp from destination B in one day?**

Meet the Artemis Team

Hear NASA's Chief Exploration Scientist Jacob Bleacher discuss the goals of the Artemis Lunar Terrain Vehicle and how NASA is partnering with industry to aid astronauts in the exploration of the Moon like never before.

Listen to this episode of the Small Steps, Giant Leaps podcast at https://appel.nasa.gov/podcast/episode-131-the-artemis-lunar-terrain-vehicle/.

This image is an artist's concept design of NASA's Lunar Terrain Vehicle.

Solution

Exercise 8: Coordinate Planes

Breakfast of Champions

Problem 1

What is the distance in kilometers from the base camp (0,0) to destination A (2,2)? What is the distance in kilometers from destination A to destination B (1,4)?
Round your answer to the nearest hundredth.

Measurements and formulas:

Formula for the distance between two points: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Solution:

Distance from base camp to destination A: $\sqrt{(2 - 0)^2 + (2 - 0)^2} = \sqrt{(2)^2 + (2)^2} = \sqrt{(4 + 4)} = \sqrt{8} = 2.83$ km

Distance from destination A to destination B: $\sqrt{(1 - 2)^2 + (4 - 2)^2} = \sqrt{(-1)^2 + (2)^2} = \sqrt{(1+4)} = \sqrt{5} = 2.24$ km

Final solution: The distance from the base camp to destination A is about 2.83 kilometers. The distance from destination A to destination B is about 2.24 Kilometers.

Problem 2

To conserve the LTV's battery, Mission Control has requested that the LTV travels less than 20 kilometers in a single day. **Given this restriction, will the LTV be able to make it back to the base camp from destination B in one day?**

Solution:

There are two ways to solve this problem. One way is to suppose that the LTV is returning to the base camp using the same route that it took to get to destination B. In this case, the total distance is equal to twice the sum of the distances found in problem 1.

Total distance: $2 \cdot (2.83 \text{ km} + 2.24 \text{ km}) = 2 \cdot (5.07 \text{ km}) = 10.14 \text{ km} < 20 \text{ km}$

Another way to solve this problem is to suppose that the LTV will return to the base camp directly from destination B. In this case, the total distance is equal to the sum of the distances found in problem 1 plus the distance from destination B to the base camp.

Distance from destination B to base camp: $\sqrt{(0 - 1)^2 + (0 - 4)^2} = \sqrt{(-1)^2 + (-4)^2} = \sqrt{(1+16)} = \sqrt{17} = 4.12$ km

Total distance: $2.83 \text{ km} + 2.24 \text{ km} + 4.12 \text{ km} = 9.19 \text{ km} < 20 \text{ km}$

Final solution: Since the total distance will be either 10.14 kilometers or 9.19 kilometers, the LTV will be able to make it back to base camp following Mission Control's restrictions.

Additional Resources

Exercise 1

- What is Artemis?
  https://www.nasa.gov/feature/artemis/
- Distance to the Moon Activity
  https://www.nasa.gov/stem-content/distance-to-the-moon/
- How Far Away is the Moon
  https://spaceplace.nasa.gov/moon-distance/en/

Exercise 2

- Light but Strong: A Lesson in Engineering Activity
  https://www.nasa.gov/wp-content/uploads/2015/04/light_but_strong_022616.pdf?emrc=044f1f
- NASA's Vehicle Assembly Building Did you know?
  https://www.nasa.gov/wp-content/uploads/2021/04/vab_graphic_sect508_fog.pdf?emrc=bdeda5
- Houston We Have a Podcast episodes: The Space Launch System: Part 1, Part 2
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/the-space-launch-system-part-1/
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/the-space-launch-system-part-2/

Exercise 3

- Houston We Have a Podcast episode: Hazard 1: Radiation
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/hazard-1-radiation/
- Purposeful Passenger: Artemis I Manikin Helps Prepare for Moon Missions with Crew
  https://www.nasa.gov/missions/artemis/orion/purposeful-passenger-artemis-i-manikin-helps-prepare-for-moon-missions-with-crew/
- Hazards to Deep Space Astronauts Lessons
  https://www.nasa.gov/stem-content/hazards-to-deep-space-astronauts/

Exercise 4

- Houston, We Have a Podcast episode: Artemis Launch Director
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/artemis-launch-director/
- How Far Will It Go? Activity
  https://www.nasa.gov/stem-content/how-far-will-it-go-a-lesson-in-graphing/
- Explore the Artemis I Website
  https://www.nasa.gov/mission/artemis-i/

Additional Resources

Exercise 5

- Secondary Payloads Infographic
  https://www.nasa.gov/image-article/secondary-payloads-infographic-2/
- Make a Moon Crater Activity
  https://www.jpl.nasa.gov/edu/resources/project/make-a-moon-crater/
- Houston, We Have a Podcast episode: Moon Geology
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/moon-geology

Exercise 6

- NASA Careers Video
  https://www.youtube.com/watch?v=HUZYnvpElk8
- Food for Thought: Eating in Space Educator Guide
  https://www.nasa.gov/stem-content/food-for-thought-eating-in-space-educator-guide/
- Houston, We Have a Podcast episode: Space Food
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/space-food/

Exercise 7

- 18 Ways NASA Uses Pi
  https://www.jpl.nasa.gov/edu/resources/project/18-ways-nasa-uses-pi/
- Artemis Camp Experience: Build a Heat Shield Activity
  https://www.nasa.gov/stem-content/artemis-camp-experience/
- Houston, We Have a Podcast episode: Artemis Recovery
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/artemis-recovery/

Exercise 8

- Houston, We Have a Podcast episode: Gateway to Partnerships
  https://www.nasa.gov/podcasts/houston-we-have-a-podcast/gateway-to-partnerships/
- Habitation with Gateway Activity
  https://www.nasa.gov/stem-content/habitation-with-gateway/
- How to Draw Artemis: LTV
  https://www.nasa.gov/wp-content/uploads/2020/06/draw_ltv_final-1.pdf?emrc=8de70d

Notes

For more information about SLS, visit:
http://www.nasa.gov/artemis
http://www.nasa.gov/sls
http://www.twitter.com/NASA_SLS
http://www.facebook.com/NASASLS
http://www.instagram.com/nasaartemis