Distribute Supplies to Space Expeditions

Number and Operations—Fractions

Grade 5

45 Min.

or

CCSS MATH
5.NF.B.4a, 5.NF.B.5b, 5.NF.B.6

TEKS MATH
5.3.I

QSC
QSC160, QSC224

LESSON OBJECTIVE
Multiply whole numbers by fractions to solve a real-world problem.

LANGUAGE OBJECTIVES
Understand the words *distribute*, *gravity*, *habitat*, and *weight* and apply them in context.

PREREQUISITE SKILLS
Multiply fractions and whole numbers.

LESSON OVERVIEW
Students calculate weights of food items at four locations in space where gravitational force varies from that of Earth's gravity. They make two plans to distribute food so that total weights at each location are about the same. They analyze their findings and check their results using bar models.

MATERIALS
- Fraction bars and circles
- Vocabulary Knowledge Rating Sheet

Science Background

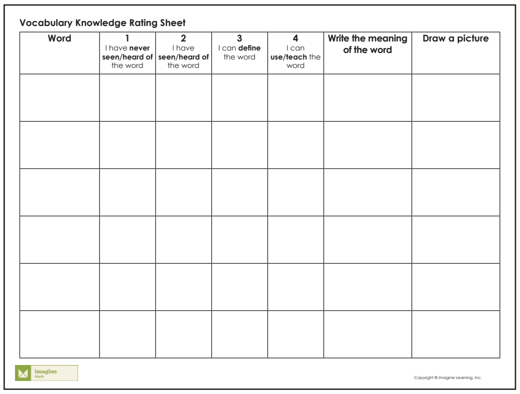
Supplying food for astronauts has been a challenge since the early days of space travel. This challenge is made even greater by extended stays on the space station and planning for future long-term expeditions to Mars and the Moon. The more a rocket weighs, the more force is required for it to launch. Overloading a rocket with supplies can cause it to crash. Because the weight of food supplies is a major concern, scientists have developed different strategies to reduce food weight. For example, spaceships are equipped with fuel cells that can provide water by producing electricity to combine with hydrogen and oxygen. This means that lightweight dehydrated food can be brought for the journey and rehydrated with the ship's water supply during the flight.

Vocabulary Knowledge Rating

Before students begin the task, pre-assess student knowledge of words used in the task. Write the words *distribute*, *gravity*, *habitat*, and *weight* for students to see. Ask students to individually say each word and then write the word on a Vocabulary Knowledge Rating Sheet using the ratings from 1–4 as shown. Once students have self-assessed, ask students to write what they think the word means, in their own words, on their rating sheet. Then, ask them to draw a picture of the word.

Throughout the task, students should discuss the meanings of the words in context of the situation.

At the end of the task, ask students to reassess their word knowledge using the same four-point scale.


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

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Task Application

In the context of calculating the weights of food items in different gravitational environments, students extend their understanding of multiplication as they multiply a whole number by a fraction and explain the relationship between products of whole numbers and fractions less than or greater than 1. Students develop two food distribution plans and use bar models to check their answers.

Guide students to understand the relationship between weight and gravity, expressed in g units. Point out that weight varies as a function of gravity. Emphasize how fractional g units that are less than and greater than 1 affect the weight of an object in a location other than Earth.

In ***section A***, students complete a table to help build fluency of multiplying fractions and whole numbers. Students who need help completing the table may benefit from using fraction bars or circles to model multiplication.

In ***section B***, students create two plans to distribute food items to at least three space expeditions so that the total weights of the food as measured at each location have a range of no more than 30 pounds.

In ***section C***, students identify one of their solutions and record the weight of each delivery at the expedition site and on Earth. Remind students that the goal is to distribute all the food items to at least three sites and for the range of weights at each expedition site to be within 30 pounds, so they should choose a plan for their solution that best meets those goals.

In ***section D***, students create bar models to check their work by using the problem-solving strategy "work backward," starting with the weight at the expedition location and working backward to arrive at the original weight on Earth. If students have difficulty creating the bar models, remind them that the denominator tells them how many parts make up one whole.

Watch Out: Common Misconceptions

Students may think that multiplying a whole number by a fraction always results in a value that is less than the whole number factor. If this is the case, suggest that students represent the fraction $\frac{5}{4}$ as a mixed number and then later as a sum of a fraction and a whole number. Explain that multiplication by $\frac{5}{4}$ is multiplication by 1 plus another $\frac{1}{4}$ of the whole number.

Students may also struggle with the mechanics of multiplying whole numbers by fractions. A common error occurs when students multiply the whole number by both the numerator and the denominator. If this is the case, remind students that multiplication by a fraction can be thought of as taking a fraction of the whole number. Encourage them to use bar models to think of $24 \times \frac{3}{8}$ as dividing 24 into 8 equal parts and then counting the value of 3 of those parts.

Sample Rubric

Score	Criteria
3	Students accurately complete the table in section A. In section B they develop two accurate plans to distribute food to at least three expedition sites and keep the range of total weights of each delivery within 30 pounds. In section C they correctly record their plans and correctly calculate the weight that each delivery would have on Earth using an appropriate strategy. In section D, they create error-free models for each of their delivery sites that can be used to work backwards from the weight at the expedition site to the weight on Earth.
2	Students complete the table in Part A with one or two errors. In section B they develop at least one accurate plan to find the total weight of food items by multiplying fractions and whole numbers. They make no more than one minor error in sections C and D as they record a plan, calculate the weight that each delivery would have on Earth using an appropriate strategy, and create models for each of their deliveries that can be used to work backwards from the weight at the expedition site to the weight on Earth.
1	Students complete the table in section A with several errors. They develop at least one accurate plan in section B to find the total weight of food items by multiplying fractions and whole numbers. Their answers in sections C and D include several incorrect calculations and demonstrate a poor understanding of math concepts.
0	Students present a very limited or rudimentary response to the assignment. They complete less than half of the table in section A accurately, make inaccurate plans or no plans to distribute the food among the space expeditions, and include very general or incomplete answers to the questions.

STEM Activity Suggestions

NGSS SCIENCE	SCIENCE AND ENGINEERING PRACTICE	MATHEMATICAL PRACTICE
NGSS 5-PS2-1	SEP2, SEP7	MP3

STEM OBJECTIVE Connect effects of gravitational forces in space to effects of gravitational forces on Earth.

1. **Build Background** Ask students to share what they know about gravity on the International Space Station. Explain that the condition there is called "microgravity," meaning that the gravitational force is so small that people and objects seem weightless. For example, astronaut Peggy Whitson recently broke the U.S. record for the most cumulative time in space. At one point during a live interview from the Space Station, Whitson let go of the microphone she was holding and it hovered in midair, instead of falling to the ground as it would on Earth.

2. **Introduce the STEM Activity** Present a scenario in which student groups have been asked to appear on a local TV show to explain how the result of gravitational force exerted by Earth on objects is different from the result of gravitational forces in space. Each group will design two demonstrations that compare what would happen if they dropped an object or rolled it down an incline on Earth to what would happen if they performed the same action on the International Space Station with the goal of delivering a video script. The video script should include dialog and detailed visual descriptions of each demonstration, along with mathematical information about how gravitational forces differ at different locations in space.

3. **Guide Teams** Students may wish to conduct actual experiments before describing demonstrations in their scripts. Encourage students to strengthen their arguments by including additional information about what might happen if they conducted their demonstrations on the Moon or Mars. Remind them to cite sources at the end of their scripts.

4. **Assess Results** The script produced by each group should include the evidence they use to support the argument that the gravitational force exerted by Earth on objects is directed down (**NGSS 5-PS2-1, SEP2, SEP7**) as well as their use of mathematical reasoning to strengthen the argument (**MP3**).

Answer Key

APPLICATION TASK | **Distribute Supplies to Space Expeditions**

Name: ____________________

Goal
Develop a food distribution plan based on how much the food items weigh at various locations in space.

How Does Gravity Affect Your Weight?
Your weight on Earth is a function of Earth's gravitational pull on you, expressed as 1 g. At a different location in space, your weight is your weight on Earth times the other location's g-force.

Connect to Reading

Weightless in Space

SpaceX supply ship arrives at space station with groceries

Essential Question **How can we solve problems by multiplying whole numbers by fractions?**

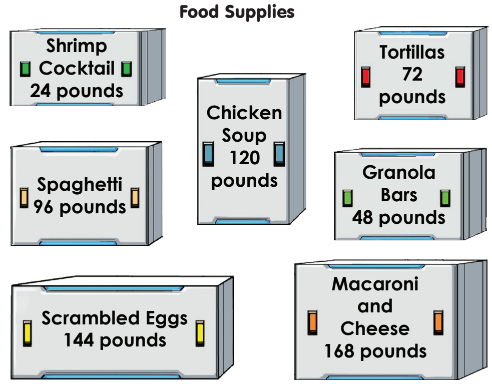
In this task, you are distributing all the food supplies shown below to at least three space expeditions. You will calculate the weights of items at each expedition's location and then divide the items so that the total weights at each location have a range of less than 30 pounds.

Gravitational Force	
Expedition Location	**g-force**
Earth	1 g
Moon	$\frac{1}{6}$ g
Mars	$\frac{3}{8}$ g
Space Habitat A	$\frac{2}{3}$ g
Space Habitat B	$\frac{5}{4}$ g

SAMPLE PLAN

Item	Moon	Mars	Space Habitat A	Space Habitat B
Shrimp Cocktail		9		
Granola Bars				60
Tortillas		27		
Spaghetti		36		
Chicken Soup	20			
Scrambled Eggs	24			
Macaroni and Cheese	28			
Total Weight	**72**	**72**		**60**

Food Supplies



Did You Know? **NASA has simulators for zero gravity, the force of gravity on the Moon, and the force of gravity on Mars.**

A | Understand

Name: ____________________

Complete the table to show the weights of the food supplies at the different expedition locations. Some values are entered for you.

Weight (pounds)

Food Supply	Earth	Moon	Mars	Space Habitat A	Space Habitat B
Shrimp Cocktail	**24**	4	9	16	30
Granola Bars	**48**	8	18	32	60
Tortillas	**72**	12	27	48	90
Spaghetti	**96**	16	36	64	120
Chicken Soup	**120**	20	45	80	150
Scrambled Eggs	**144**	24	54	96	180
Macaroni and Cheese	**168**	28	63	112	210

Think about It Use vocabulary words to complete the sentences.

A box of granola bars weighs 48 pounds on Earth. The box's ___weight___ on Mars is the ___product___ of 48 and $\frac{3}{8}$. $\frac{3}{8}$ is the ___g-force___ of Mars.

Explain It Items on Space Habitat B weigh more than they do on Earth. Why?

Sample answer: The g-force for Space Habitat B is $\frac{5}{4}$, which is greater than 1. Multiplying a fraction greater than 1 and a whole number results in a product that is greater than the whole number.

Talk about It Talk about how to solve this problem with a partner. Discuss how the table in ***section A*** helps you meet the requirements of the task.

ACADEMIC AND MATH VOCABULARY

Read each definition. Use these words in discussions and responses to thinking questions.

distribute: to divide into parts

expedition: an organized journey or trip

g: A standard gravity value defined by the International Bureau of Weights and Measures. It states that 1 g corresponds to gravity on Earth.

g-force: a measurement of the value of g, gravity, at a given location

gravity: A force of attraction or downward pull. Gravity on Earth makes everything fall downward toward Earth. Since Mars is a smaller planet than Earth, it has less gravity.

B | Organize

Name: ____________________

For each plan, enter item weights and the total weights for at least three expedition locations. The range in total weights must be less than 30 pounds.

Plan 1

Food Supply	Earth	Moon	Mars	Space Habitat A	Space Habitat B
Shrimp Cocktail	**24**		9		
Granola Bars	**48**			32	
Tortillas	**72**		27		
Spaghetti	**96**		36		
Chicken Soup	**120**				150
Scrambled Eggs	**144**		54		
Macaroni and Cheese	**168**			112	
Total Weight			126	144	150

Plan 2

Food Supply	Earth	Moon	Mars	Space Habitat A	Space Habitat B
Shrimp Cocktail	**24**			16	
Granola Bars	**48**				60
Tortillas	**72**			48	
Spaghetti	**96**	16			
Chicken Soup	**120**	20			
Scrambled Eggs	**144**	24			
Macaroni and Cheese	**168**		63		
Total Weight		60	63	64	60

Explain It What do you notice about the items delivered to each location?

Sample answer: Locations with low g-force values receive more food items than locations with high g-force values.

ACADEMIC AND MATH VOCABULARY *(continued)*

product: the result you get when you multiply two numbers

range: the difference between the least value and the greatest value in a data set

simulator: a device that creates a realistic imitation of the conditions in an environment, such as zero gravity in space

space habitat: a type of space station intended as a permanent settlement

weight: the mass of an object multiplied by the downward gravitational force; how heavy an object is

whole number: a number greater than or equal to zero that is not a fraction or decimal

C | Solve

Name: ____________________

Choose one plan. List the items and total weights for each expedition that receives food supplies.

Total Weight of Food Supplies at Expedition Location and on Earth (lb)

Expedition	Moon	Mars	Space Habitat A	Space Habitat B
Items	Spaghetti Chicken Soup Scrambled Eggs	Macaroni and Cheese	Shrimp Cocktail Tortillas	Granola Bars
Total Weight on Expedition	16 + 20 + 24 = 60	63	16 + 48 = 64	60
Total Weight on Earth	360	168	96	48

D | Check

Use bar models to check your solution. One model has been completed for you as an example.

Moon

Weight on Earth

60 lb

Weight on the Moon
60 ÷ 1 = 60
60 × 6 = 360

Mars

Weight on Earth

63 lb

Weight on Mars
63 ÷ 3 = 21
8 × 21 = 168

Space Habitat A

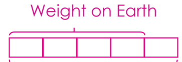
Weight on Earth

64 lb

Weight on Habitat A
64 ÷ 2 = 32
3 × 32 = 96

Space Habitat B

Weight on Earth



60 lb

Weight on Habitat B
60 ÷ 5 = 12
4 × 12 = 48

CONNECT TO SCIENCE

The effect of gravity must be considered when planning a space expedition.

What kinds of food supplies do astronauts use in space?

Sample response: Astronauts now eat many of the same foods they eat on Earth. However, the food needs to be prepared in special ways.

Is it fair to divide the food items based on the weight of the items at each expedition location? Explain your reasoning.

Sample response: No, it is not fair because someone on the Moon would receive much more food than someone on Space Habitat B.

Extend Weigh objects in the classroom and calculate their weight at expedition locations.

Sample answer: The weight of a pencil is 10 grams on Earth. On the Moon, its weight would be 10 ÷ 6 or about 1.66 grams. On Mars, its weight would be $10 \times \frac{3}{8}$ or 3.75 grams. On Habitat A, its weight would be $10 \times \frac{2}{3} = 6\frac{2}{3}$ grams. On Habitat B, its weight: $10 \times 5\frac{5}{4} = 12.5$ grams.

Name: ___________________________

Weightless in Space

Written by Raymond Lamborn
Illustrated by Maryn Roos
Lexile®: 970L,194 words

Did you know that your weight would be different in outer space? It would also be different if you were on another planet.

If you weigh 100 pounds on Earth, you would weigh less than 40 pounds on Mars—but you'd weigh more than 250 pounds on Jupiter.

How does your weight change from planet to planet? It's all about gravity. When two bodies, like your body and the Earth, get near each other in space, they automatically pull towards each other. That pull is called gravity.

Since the Earth is so much bigger than you are, it pulls you tightly to its surface—and you could never just float away. The bigger you are, the harder the Earth pulls, and it is this pull that your bathroom scale measures.

If you were on a smaller planet like Mars, the pull on your body would be much less, so you would weigh less. But if you were on a gigantic planet like Jupiter, the pull on you would be much stronger, and you would weigh a lot.

If you'd like to learn more about gravity and space, you might want to become an astronaut!

Name: ____________________________

SpaceX supply ship arrives at space station with groceries

MARCIA DUNN, AP Aerospace Writer
January 12, 2015
Lexile®: 860L, 191 words

CAPE CANAVERAL, Fla. (AP) — A shipment of much-needed groceries and Christmas presents finally arrived Monday morning at the International Space Station. The SpaceX company's supply ship, Dragon, pulled up at the orbiting lab two days after its launch. Station commander Butch Wilmore used a robot arm to grab the capsule and its 5,000 pounds of cargo.

The space station's six astronauts were getting low on supplies. The previous supply ship, owned by Orbital Sciences Corp., was destroyed in a launch explosion in October. NASA scrambled to get equipment lost in the blast aboard Dragon.

Dragon should have arrived well before Christmas but there were issues with the rockets. Dragon was stalled for a month. "We're excited to have it on board," U.S. astronaut Wilmore said. "We'll be digging in soon." He's especially excited to get more mustard. The station's cabinet of condiments is empty.

NASA is paying SpaceX and Orbital for shipments. But Orbital's rockets are grounded until next year because of its launch accident. SpaceX is the only supplier capable of returning items to Earth. The company is delivering as many supplies as possible.

Russia and Japan also plan to send deliveries this year.

Accuracy: # of reading errors: __________	(Indep. = 0–4, Instr. = 5–10, Frust. = 11+)
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