

Task: Title
Course and Grade Level

A requisition was sent to the warehouse at a major industry, which produces toothpaste in Morristown, TN. An eighteen-wheeler needed to be loaded to maximize the space and weight limits. These amounts must remain within the requirements established by the Federal Motor Carrier Authority. A trailer's dimensions are 53 ft. by 102 in. by 13.5 ft. The trucks total weight must be no more than 80,000 lbs. Each pallet's dimensions are 45" x 48" x 60".

Part 1:

- a. Use the areas of the trailer and a pallet to determine how many pallets can be used one to fill the floor of the trailer? How many pallets can be evenly placed on the floor of the trailer.
- b. What is the volume of the trailer and a pallet?
- c. What is the maximum number of pallets that can be stacked into the trailer to fill it to its capacity? Explain how you determined you answer.

Part 2:

The tractor-trailer may not exceed 80,000 lbs. The tractor and trailer part of each rig is 38,000 lbs. What is the most each load can weigh?

Size	Ounces per tube	# Of tubes per case
Trial size	3 oz.	36
Family size	8 oz.	24

- a. Truck one will load trial size toothpaste tubes, while truck two will carry family size tubes. How many tubes and cases can be found on each load?
- b. Write a linear equation to express how many tubes of each will produce a full load.

Each pallet will have a different weight depending upon the freight loaded unto each pallet. If the loader needs to fill his truck to maximize the truck space limits how many tubes and cases can be loaded unto each truck?

Common Core State Standards

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

3102.1.2 Write an equation symbolically to express a contextual problem.

3102.4.4 Convert rates and measurements.

3102.3.5 Write and/or solve linear equations, inequalities, and compound inequalities including those containing absolute value.

Essential Understandings

Students should be able to calculate the area of a rectangle and the volume of a rectangular prism. They should also be able to determine the total number of pallets that can theoretically be placed on the floor of the trailer and used to fill the trailer.

Students should be able determine the volume of the rectangular prism.

Students should understand linear equations.

Possible Solutions/Solution Paths

Part 1:

a. Total Area of trailer ($A = l \times w$) $636 \times 102 = 64,872 \text{ in}^2$

$$53 \times 8.5 = 450.5 \text{ ft}^2$$

Total Area of pallet ($A = l \times w$) $45 \times 48 = 2,160 \text{ in}^2$

$$3.75 \times 4 = 15 \text{ ft}^2$$

in^2 $64,872 / 2160 = 30.03$ or 30 pallets

ft^2 $450.5 / 15 = 30.03$ or 30 pallets

Find the volume of each and divide the area of the trailer by the area of the pallet.

Theoretically this is the answer, but it doesn't allow for space between pallets and moving room for the forklift. Maybe a more realistic answer would be 26 to 28 pallets.

b. Total Volume of a trailer ($V = l \times w \times h$)	$636 \times 102 \times 162 = 10,509,264 \text{ in}^3$
	$53 \times 8.5 \times 13.5 = 6,081.75 \text{ ft}^3$
Total Volume of a pallet ($V = l \times w \times h$)	$45 \times 48 \times 60 = 129,600 \text{ in}^3$
	$3.75 \times 4 \times 5 = 75 \text{ ft}^3$

$\text{in}^3 \quad 10,509,264 / 129,600 = 81.09 \text{ or } 81 \text{ pallets}$
 $\text{ft}^3 \quad 6,081.75 / 75 = 81.09 \text{ or } 81 \text{ pallets}$

If a trailer is 13.5 ft. (or 162 inches), and a pallet is 5 ft. (or 60 in.), the pallets can only be stacked two high. There will be room at the top of the trailer 3.5 ft. (or 42 in.). Which is $1,576.75 \text{ ft}^3$ of unused space at the top of each trailer.

$53 \times 8.5 \times 3.5 = 1,576.75 \text{ ft}^3 \quad 6,081.75 - 1,576.75 = 4,505 \text{ ft}^3$
 Therefore only $4,505 \text{ ft}^3$ will be used space. Realistically you cannot divide the pallets standard height and product. This will account for the discrepancy in 30 pallets doubled (or 60 pallets) and the 81 pallets that is determined if pallets were stacked directly upon one another and divided up using maximum volume of trailer.

Part 2:

$80,000 - 38,000 = 42,000 \text{ lbs.}$

Convert 8 oz. to .5 lbs. and 3 oz. to .1875 lbs.

Linear Equation $y = mx + b$

Truck 2

$80,000 = .5x + 38,000$

$-38,000 \quad -38,000$

$42,000 = .5x$

$84,000 \text{ 8-oz tubes} = x$

$84,000/24 = 3,500 \text{ cases}$

$3,500 \text{ cases}$

Truck 1

$80,000 = 3x + 38,000$

$-38,000 \quad -38,000$

$42,000 = .1875x$

$224,000 \text{ 3-oz tubes} = x$

$224,000/36 = 6,222 \text{ cases}$

$6,222 \text{ cases}$

Additional Teacher Information

In reality there are many more details to filling a trailer to its load optimization, these can be discussed to promote higher order thinking and problem solving.