



Question 1

RUBRIC

Score	Description
4	Response demonstrates thorough understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. Explanations may be somewhat vague and/or there may be some mathematical errors.
1	Response demonstrates limited understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE

Explain how you determined how many pallets will fit into a car and how many cars are needed to ship all the pallets.

First, I figured out how many pallets would fit into a car. I divided the length of the car by the width and the length of a pallet. I also divided the width of the car by the length and width of each pallet. If I load the car with the long sides (48") of the pallets to the back, I can fit 21 pallets, front to back. I can make two rows of 21 pallets. Then, I divided the height of the car by the height of a pallet and found I could load a second layer of pallets on top of the first layer, for a total of 84 pallets in a car. (If I turned the pallets so the short sides (40") were toward the back, I could only fit 72 pallets.)

Next, I found the total number of pallets. There are 7500 cases of apples and 30 cases fit on a pallet. I figured the number of pallets: $7500 \div 30 = 250$ pallets. Then, I figured the number of cars: $250 \text{ pallets} \div 84 \text{ pallets in a car} = 2.97$ cars.

How much did you save the company by finding the least-cost scenario? Explain how you know.

If I had loaded the pallets the other way, I would have needed another car. Each car must travel 4 legs and the cost is \$750 per leg. If I added another car, it would have cost the company another \$3000.

Question 2**RUBRIC**

Score	Description
4	Response demonstrates thorough understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. Explanations may be somewhat vague and/or there may be some mathematical errors.
1	Response demonstrates limited understanding of rectangular volume and the use of rotations to maximize the number of pallets that will fit into a car. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE

Explain how you determined how many pallets will fit in a car.

There are two different sizes of covered box cars, so I had to figure the cost using each car. I divided the length of the car by the width and length of a pallet. Then, I divided the width of the car by width and length of a pallet. Last, I divided the height of the car by the height of a pallet to find how many I could stack on top of each other. It did not matter which way I load the pallets widthwise. Either way, I could put 2 across. It did matter lengthwise. If I load the pallets with the long side toward the back, I can fit 3 more pallets in each row, front to back. With two rows of pallets, stacked 3 high, I can load 108 pallets into a 60' car or 90 pallets into a 50' car.

Explain how you found the number of cars needed and the total cost.

There are a total of 500 pallets. I found the number of cars by dividing the total number of pallets by the number of pallets per car. If I use a 60' car, I need 5 cars. If I use a 50' car, I need 6 cars. It's cheaper to use more of the smaller cars. It will cost \$18750 for five 60" cars ($5 \text{ cars} \times 5 \text{ legs} \times \$750 = 18750$) or 18000 to use six 50" cars ($6 \text{ cars} \times 5 \text{ legs} \times \600).

Question 3

RUBRIC

Score	Description
5	<p>Response demonstrates exceptional understanding of applying geometric principles. The student completely, clearly and accurately explains the following.</p> <ul style="list-style-type: none"> • How to find the volume of the top compartment. • How to find the dimensions of the bottom compartments. • How find the volume of a pyramid. • How to convert cubic feet to cubic yards. • How to find the volume of salt. <p>All explanations are exceptionally clear and all mathematics is completely correct.</p>
4	Response demonstrates general understanding of applying geometric principles. All explanations are clear and all mathematics is completely or mostly correct.
3	Response demonstrates reasonable understanding of applying geometric principles. Explanations may be somewhat vague and/or there may be some mathematical errors. Explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of applying geometric principles. Explanations are vague and/or there are mathematical errors.
1	Response demonstrates limited understanding of applying geometric principles. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE**Explain how you determined the volume of a covered hopper.**

First I figured the volume of the top compartment by multiplying length x width x height. I got 3698.7 cubic feet. Then, I had to convert cubic feet to cubic yards. I divided by 27 to get 136.99 yd³.

To find the volume of one bottom compartment, first I had to figure out the dimensions. The base of each pyramid is 17.78' x 10.67' and each is pyramid is 6.5' tall. The formula for finding the volume of a pyramid is $(L \times W \times H)/3$. I found that each pyramid holds 411.04 ft³, so altogether the bottom compartments hold 1233.9 ft³. Again, I converted to cubic yards: $1233.13 \div 27 = 45.7$ yd³.

Explain how you determined the volume of salt and the number of cars required to ship it.

To figure out the volume of the salt, I had to convert the weight of the salt from tons to pounds (200 tons of salt x 2000 pounds = 400,000 pounds). I was told that each cubic yard of salt weighs 2160 pounds, so I divided the total weight of the salt (in pounds) by 2160. Almost all of the salt would fit in the car, but the salt is too heavy. There is a 223,500 pound weight limit for the car. I converted the weight limit to tons ($223500 \div 2000 = 111.75$ tons.) I have 200 tons of salt. To maintain the weight limit, I will need 2 cars.

Question 4

RUBRIC

Score	Description
4	Response demonstrates thorough understanding of applying geometric principles. The student completely, clearly and accurately explains: <ul style="list-style-type: none"> • How to find the volume of the top compartment. • How to find the dimensions of the bottom compartments. • How find the volume of a pyramid. • How to find the volume of a cylinder. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of applying geometric principles. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of applying geometric principles. Explanations are vague and/or there are mathematical errors.
1	Response demonstrates limited understanding of applying geometric principles. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE

Explain how you determined the volume, in cubic feet of one car.

First, I determined the volume of the top compartment in cubic feet. I converted all the measures to a decimal. Then, I multiplied $L \times W \times H$

$$53.33' \times 10.67' \times 6.5' = 3698.70 \text{ ft}^3$$

Then, I figured out the dimensions (in feet) of each pyramid in the bottom compartment and used the formula $(L \times W \times H)/3$ to find the volume.

$$\frac{17.78 \times 10.67' \times 6.5'}{3} = \frac{1233.13'}{3} = 411.04 \text{ cu. ft.}$$

Then, I multiplied by 3, as there are 3 compartments. $411.04 \times 3 = 1233.12 \text{ ft}^3$

Altogether, the compartments hold $3698.70 \text{ ft}^3 + 1233.12 \text{ ft}^3 = 4931.82 \text{ ft}^3$.

Explain how you determined the volume of barley.

I used the formula for the volume of a cylinder to find the volume of barley in each silo.

$$V = \pi r^2 h = \pi (30/2)^2 26.75 = 3.14 \times 15^2 \times 26.75 = 3.14 \times 225 \times 26.75 = 18,898.88 \text{ cu. ft.}$$

Because there are 2 silos, I multiplied by 2: $18,898.88 \text{ ft}^3 \times 2 \text{ silos} = 37,797.76 \text{ ft}^3$

Question 5

RUBRIC

Score	Description
4	Response demonstrates thorough understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. Explanations may be somewhat vague and/or there may be some mathematical errors.
1	Response demonstrates limited understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE

Tanker cars are shaped like a cylinder. The formula for finding the volume of a cylinder is $V = \pi r^2 h$.

$$V = \pi r^2 h = \pi \left(\frac{10.67}{2} \right)^2 53.83 = 3.14 \times 5.34^2 \times 53.83 = 3.14 \times 28.51 \times 53.83 = 4820.63 \text{ cu. ft.}$$

Then, I found the volume of the fertilizer. There are 140,000 gallons of fertilizer and every 7.5 gallons is 1 cubic foot. ($140,000 \div 7.5 = 18,666.67 \text{ ft}^3$)

To find the number of cars, I divided the volume of fertilizer by the volume of one car: $18,666.67 \text{ ft}^3 \div 4,820.63 \text{ ft}^3 = 3.87$; Rounded up it takes 4 cars.

Question 6

RUBRIC

Score	Description
4	Response demonstrates thorough understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. Explanations may be somewhat vague and/or there may be some mathematical errors.
1	Response demonstrates limited understanding of computing the volume of a cylinder and conversions between gallons and cubic feet. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

Answers will vary slightly, due to rounding. The variation is acceptable, as all calculations are considered estimates.

SAMPLE RESPONSE

First I found the volume of the car, using the formula for the volume of a cylinder.

$$V = \pi r^2 h = \pi \left(\frac{10.66}{2} \right)^2 53.83 = 3.14 \times 5.33^2 \times 53.83 = 3.14 \times 28.41 \times 53.83 = 4802.03 \text{ cu. ft.}$$

To find the volume of the chemicals, I had to convert gallons to cubic feet. 160,000 gallons \div 7.5 gallons per $\text{ft}^3 = 21,333.3 \text{ ft}^3$

Then, I divided the volume of the chemicals by the volume of a car to find how many cars I need.

$$21333.3 \text{ ft}^3 \div 4802.03 \text{ ft}^3 = 4.44 \text{ (5 cars)}$$

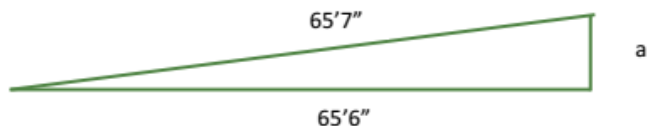
Question 7**RUBRIC**

Score	Description
4	Response demonstrates exceptional understanding of applying the Pythagorean theorem. The student completely, clearly and accurately explains how to use the Pythagorean Theorem to show how the logs fit into the car and why only a single row of logs can be shipped in each car. All explanations are exceptionally clear and all mathematics is completely correct.
3	Response demonstrates general understanding of applying the Pythagorean theorem. The student generally explains how to use the Pythagorean Theorem to show how the logs fit into the car and why only a single row of logs can be shipped in each car. All explanations are clear and all mathematics is completely or mostly correct.
2	Response demonstrates partial understanding of applying the Pythagorean theorem. Explanations are vague and/or there are mathematical errors.
1	Response demonstrates limited understanding of applying the Pythagorean Theorem. Explanations are vague and/or there are mathematical errors.
0	The student's response is all or mostly incorrect.

SAMPLE RESPONSE

Explain how you know that the logs will fit into a car and how many cars are required to ship them.

The logs are too long to lie flat, so I used the Pythagorean Theorem to see if they would fit at an angle.



$$65.58^2 = 65.5^2 + a^2$$

$$4300.74 = 4290.25 + a^2$$

$$a^2 = 4300.74 - 4290.25 = 10.49$$

$$\sqrt{a^2} = \sqrt{10.49}$$

$$a = 3.24 \approx 3.25$$

The logs fit. The lower side of a log extends about 3.25 feet up the side of the car. Because the logs are 3 feet wide, the top side of the log extends 6.25 feet up the side of the car. I can fit only one layer of logs, because two layers would extend 9.25 feet and the car is only 8 feet 6 inches tall.

Widthwise, I can fit 3 logs (9 feet \div 3 feet = 3). With 3 logs in a car, I need 7 cars to ship all 20 logs (one car will have only 2 logs).

Question 8

RUBRIC

Score	Description
14	Assign 2 points for each row that is filled-in completely and correctly. <i>NOTE: Calculations of the amount of freight per car will vary slightly, due to rounding. The variation is acceptable, since all calculations are considered estimates.</i>

SAMPLE RESPONSE

Outbound Route Data

From	To	Freight	Amount of Freight	Car Type	Amount of Freight per Car	# of Rail Cars Needed	# of Legs	Cost per Leg	Total shipping cost
Boston, MA	Chicago, IL	Apples	7,500 cases	Refrigerated Boxcar	250 pallets	3	4	\$750	\$9000
Boston, MA	Detroit, MI	Molded Dashboard Covers	500 pallets	50' Covered boxcar	90 pallets	6	5	\$600	\$18,000
Newark, NJ	Pittsburgh, PA	Road salt	200 tons	Covered Hopper	110 tons	2	1	\$1000	\$2000
Pittsburgh, PA	Indianapolis, IN	Liquid Fertilizer	140,000 gallons	Tanker car	4820.63 ft ³	4	1	\$1000	\$4000

Return Route Data

From	To	Freight	Amount of Freight	Car Type	Amount of Freight per Car	# of Rail Cars Needed	# of Legs	Cost per Leg	Total shipping cost
Detroit, MI	Chicago, IL	Fresh Cut Cedar Logs	20 logs	Plain Gondola	3 logs	7	1	\$750	\$5,250
Chicago, IL	Newark, NJ	Plastic chemicals	160,000 gallons	Tanker Car	4820.633 ft ³	5	2	\$1000	\$10,000
Indianapolis, IN	Boston, MA	Barley	2 full grain silos	Covered Hopper	4931.82 ft ³	8	2	\$1000	\$16,000

Question 9

RUBRIC

Score	Description
1	Assign 1 point for each stop that is completely correct.

SAMPLE RESPONSE

Boston

1. Load six 50' Covered Box Cars with molded dashboard covers.
2. Load 3 Refrigerated Box Cars of apples

Newark

1. Load 2 Covered Hoppers of road salt

Pittsburgh

1. Unload 2 Covered Hoppers of road salt
2. Load 4 Tankers of liquid fertilizer

Indianapolis

1. Unload 4 Tankers of liquid fertilizer

Chicago

1. Unload 3 Refrigerated Box Cars of apples

Detroit

1. Unload six 50' Covered Box Cars with molded dashboard covers.
2. Load 7 Plain Gondolas of fresh cut logs

Chicago

1. Unload 7 Plain Gondolas of fresh cut logs
2. Load 5 Tankers of plastic chemicals

Indianapolis

1. Load 8 Covered Hoppers of barley

Newark

1. Unload 5 Tankers of plastic chemicals

Boston

1. Unload 8 Covered Hoppers of barley