Math
Released Item 2018

Geometry

Height of a Bucket Truck
M46629
Anchor Set
A1 – A8

With Annotations
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.
<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
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<tbody>
<tr>
<td>3</td>
<td>Student response includes the following 3 elements.</td>
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<tr>
<td></td>
<td><strong>Modeling component</strong> = 2 points</td>
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<td>o Correct reasonable estimate for the height of the building with explanation</td>
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<tr>
<td></td>
<td>o Correct work or explanation for the length of the arm of the bucket truck</td>
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<td></td>
<td><strong>Computation component</strong> = 1 point</td>
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<td>o Correct reasonable length of the arm of the bucket truck</td>
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Sample Student Response:

If the door is 7.5 feet and it’s about 3 sheets of metal siding tall, then I estimated the height of 3 sheets as follows.

7.5 feet = 90 inches

90 inches divided by 3 sections is about 30 inches per section

I counted the sections on the building, adding one section for the windows at the top and one more section on top of the windows for a total of about 23 sections.

This is 23(30) or about 690 inches or about 57.5 feet.

The height of the bucket arm is 6 feet off the ground. That would leave 57.5 - 6 = 51.5 feet of height the arm would need to reach. A model can be a right triangle formed by the bucket arm, a line parallel to the ground, but up 6 feet, and the vertical height off the truck of the bucket arm. The bucket arm length, \( a \), can be estimated using a sin function.

\[
\sin 70 = \frac{51.5}{a} \\
\sin 70 \cdot a = 51.5 \\
a = \frac{51.5}{\sin 70} \\
a = 54.8
\]

The arm would need to be at least 54.8 feet to reach the top of the building.
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<thead>
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<tbody>
<tr>
<td><strong>2</strong></td>
<td>Student response includes 2 of the 3 elements.</td>
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<tr>
<td><strong>1</strong></td>
<td>Student response includes 1 of the 3 elements.</td>
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<td><strong>0</strong></td>
<td>Student response is incorrect or irrelevant.</td>
</tr>
</tbody>
</table>

The minimum arm length on the bucket truck the repairman should rent to reach the top of the building would be 55 feet.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

\[
\begin{align*}
7.5 \div 3 &= 2.5 \text{ ft for each sheet.} \\
2.5 \times 23 &= 57.5 \text{ ft is the approximate height of the building.} \\
\text{There's 21 sheets plus a possible two more sheets at the top.} \\
57.5 - 6 &= 51.5 \text{ ft to the top from the beginning of the arm.} \\
\sin 70 &= 51.5 \div X \\
X &= \text{Bucket Arm Length} \\
X \times \sin 70 &= 51.5 \\
\therefore \div \sin 70 \\
X &= 55 \text{ ft.}
\end{align*}
\]
**Annotation**

**Anchor Paper 1**  
**Score Point 3**

This response receives full credit. The student includes each of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation ($7.5 \div 3 = 2.5$ ft for each sheet; $2.5 \times 23 = 57.5$ ft is the approximate height of the building; 21 sheets plus a possible two more sheets at the top).

- The response shows a reasonable length of the arm for the bucket truck (55 ft.).

- The response includes a valid explanation for the length of the bucket truck arm ($57.5 - 6 = 51.5$ ft to the top from the beginning of the arm; $\sin 70 = 51.5 \div X; X = \text{Bucket Arm Length}; X \times \sin 70 = 51.5; X = 55$ ft.).
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

If the door of the building is 7.5 feet tall, then a sheet of metal must be about 2.5 feet tall, since the door takes up $3.21 \times 2.5 = 52.5$ feet. $52.5 - 6 = 46.5$

$$x = \frac{46.5}{\sin 70}$$

$$x = 49 \text{ feet}$$
This response receives full credit. The student includes each of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation (the door of the building is 7.5 feet tall, then a sheet of metal must be about 2.5 feet tall, since the door takes up 3; $21 \times 2.5 = 52.5$ feet).

- The response shows a reasonable length of the arm for the bucket truck (49 ft.).

- The response includes a valid explanation for the length of the bucket truck arm ($52.5 - 6 = 46.5; x = \frac{46.5}{\sin 70}; x = 49$ feet).

Note: The height of the building can be determined based upon stopping where the sheets stop. The acceptable values of the height of the building will vary depending upon the student’s understanding of the space located above the horizontal line where the sides of the building begin to angle inward.

Note: The length of the arm can vary based on the height of the building.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is the best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

My best estimate is 52.5 feet.
There are 21 sections and a 7.5 ft. door makes 3.
21 divided by 3 equals 7.
7 times 7.5 equals 52.5 ft.

\[
\sin 70° \div 1 = 46.5 \div x
\]
\[
x = \text{missing length}
\]
\[
46.5 \div \sin 70 \approx 60.09 \text{ feet}
\]

It should be about 60 feet.
This response receives partial credit. The student includes two of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation (the best estimate is 52.5 feet; 21 sections and a 7.5 ft. door makes 3; 21 divided by 3 equals 7; 7 times 7.5 equals 52.5 ft.).

- The response includes a valid explanation for the length of the bucket truck arm ($\sin 70° \div 1 = 46.5 \div x; x = \text{missing length}; 46.5 \div \sin 70 \approx 60.09$ feet).

The response does not show a reasonable length of the arm for the bucket truck (It should be about 60 feet). The response shows an incorrect value because the student used radians instead of degrees.

Note: The height of the building can be determined based upon stopping where the sheets stop. The acceptable values of the height of the building will vary depending upon the student’s understanding of the space located above the horizontal line where the sides of the building begin to angle inward.

Note: The response shows the result of subtracting the 6 feet from the height of the building which is acceptable for credit. The height of the building from element 1 is 52.5, but the value used to determine the length of the arm is 46.5.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck's arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

The height of the building is 57.5 feet. The door takes up about 3 metal sheet spaces. $7.5 \div 3 = 2.5$.
Number of metal sheet spaces is 23; the windows are the height of one sheet space. $23 \times 2.5 = 57.5$ The bucket arm length is about 61 feet. 

$\sin 70 = \frac{57.5}{x}$. Multiply $x$ to both sides. $\sin 70 \times x = 57.5$. Divide both sides by $\sin 70$. $x = 61.19$ rounded to the nearest foot is 61.
Only the length of the bucket arm was asked for so the 6 ft isn’t needed.
This response receives partial credit. The student includes two of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation (the height of the building is 57.5 feet; door takes up about 3 metal sheet spaces. $7.5 \div 3 = 2.5$; number of metal sheet spaces is 23; windows are the height of one sheet space; $23 \times 2.5 = 57.5$).

- The response shows a reasonable length of the arm for the bucket truck (rounded to the nearest foot is 61). The length of the arm is correct based on incorrectly failing to adjust for the 6 ft. truck height.

The response does not include a valid explanation for the length of the bucket truck arm ($\sin 70 = \frac{57.5}{x}$. Multiply $x$ to both sides. $\sin 70 \times x = 57.5$. Divide both sides by $\sin 70$. $x = 61.19$; Only the length of the bucket arm was asked for so the 6 ft isn’t needed) because there is no adjustment for the height of the truck.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

The best estimate for the height of the building is 57.5 ft. tall, I got this by seeing that the door took up 3 sheets of metal and the door is 7.5 ft. tall so I divided that by 3 to get 2.5, once I got that I multiplied that by 23 because there are 21 sheets of metal and the roof is around 2 or those. The bucket arm has to be greater than 157.5 due to the fact the bucket won’t go straight up, but you’re already off the ground 6 feet because that’s the height of the truck.
This response receives partial credit. The student includes one of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation (the best estimate for the height of the building is 57.5 ft. tall; the door took up 3 sheets of metal and the door is 7.5 ft. tall so I divided that by 3 to get 2.5; multiplied that by 23 because there are 21 sheets of metal and the roof is around 2 or those).

The response does not show a reasonable length of the arm for the bucket truck (greater than 157.5).

The response does not include a valid explanation for the length of the bucket truck arm (the bucket wont go strait up, but you’re already off the ground 6 feet).
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally spaced from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is $70^\circ$.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

The building is about 52.5 feet tall. The door is 7.5 feet tall and has three metal sheets going through it. 
$7.5 \div 3 = 2.5$
Each metal sheet is 2.5 feet tall.
There are 21 metal sheets on the whole building. (counted)
$21 \times 2.5 = 52.5$ ft

He needs to have at least a 49.2 foot arm.
\[
\sin \frac{71}{1} = \frac{52.5}{x}
\]
$52.5 = \sin (71)x$
$52.5 \div \sin (71) = 55.20$
$55.20 - 6 = 49.20$
Subract six because the arm is already six feet off the ground.
The arm has to be 49.20 feet.
This response receives partial credit. The student includes one of the three required elements.

- The response shows a reasonable estimate for the height of the building with explanation (about 52.5 feet tall; door is 7.5 feet tall and has three metal sheets; $7.5 \div 3 = 2.5$; Each metal sheet is 2.5 feet tall; 21 metal sheets on the whole building; (counted); $21 \times 2.5 = 52.5$ ft).

The response does not show a reasonable length of the arm for the bucket truck (49.20 feet).

The response does not include a valid explanation for the length of the bucket truck arm ($\frac{\sin 71}{1} = \frac{52.5}{x}; 52.5 = \sin(71)x; 52.5 \div \sin(71) = 55.20; 55.20 - 6 = 49.20$).

Note: The student incorrectly included the angle measure of 71 instead of 70. Additionally, the 6 foot deduction for the height of the truck was deducted from the length of the arm instead of the height of the building.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

The building is around 52.5 feet tall.

\[ 7.5 \times 7 = 52.5 \]

\[ 52.5 \div 1.5 = 35 \]

The bucket arm will have to reach 35 feet.
This response receives no credit. The student includes none of the three required elements.

The response shows a reasonable estimate for the height of the building but includes an incomplete explanation (building is around 52.5 feet tall; $7.5 \times 7 = 52.5$).

Note: The student does not provide the origin of the values included in the equation. The response does not show that three sheets are 7.5 feet tall or that there are 21 sheets up the side of the building if the portion above the horizontal sheet where the sides adjust inward is not included.

The response does not show a reasonable length of the arm for the bucket truck (35 feet).

The response does not include a valid explanation for the length of the bucket truck arm ($52.5 \div 1.5 = 35$). The response uses the determined height of the building and divides it by an unknown value.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

From the ground to the top of the roof is approximately 53.66 feet tall. I assumed that the windows at the top of the building are the same size as the window closest to the bottom and that I added another sheet of metal on the top between the top windows and the top of the roof for a more exact estimate. The repairman needs at least a forty-seven-foot bucket arm.
This response receives no credit. The student includes none of the three required elements.

The response does not show a reasonable estimate for the height of the building and correct explanation (approximately 53.66 feet tall; I assumed that the windows at the top of the building are the same size as the window close to the bottom and I added another sheet of metal on the top between the top windows and the top of the roof for a more exact estimate). The response gives some information about how to determine the total number of sheets of metal, but does not provide any values as to the number of sheets or the size of the sheets.

The response includes an incorrect length of the arm for the bucket truck (a forty seven foot bucket arm).

The response does not include a valid explanation for the length of the bucket truck arm.
Practice Set
P1 - P5

No Annotations Included
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally spaced from the bottom to the top of the building. A bucket truck's arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

\[
\begin{align*}
7.5 \div 3 &= 2.5 \\
\text{sheet of metal is } 2.5 \text{ ft tall} \\
\text{there is about 23 metal sheets} \\
2.5 \times 23 &= 57.5 \\
\text{the building is about } 57.5 \text{ ft tall} \\
57.5 - 6 &= 51.5 \\
\text{the minimum height of the arm needs to be } 51.5 \text{ ft tall}
\end{align*}
\]
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck's arm is 6 feet off the ground and its maximum angle is $70^\circ$.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

The building is most likely around 57.5 feet tall. Since the door is 7.5 feet tall, and the door is three slats high, the slats must each be 2.5 feet tall. Since there are 21 slats and approximately the height of 2 slats above those, and $23 \times 2.5$ is 57.5, the building is about 57.5 feet tall. Since the maximum angle of the bucket arm is $70^\circ$, minimum length of the bucket arm must be equal to $x$ when $\sin 70 = \frac{51.5}{x}$, since the bucket arm is already 6 feet off of the ground, so it only has to reach 51.5 feet. By dividing both sides by $\sin 70$ and multiplying both by $x$, that equation ends up as $x = \frac{51.5}{\sin 70}$.

Once that is solved, we end up with $x \approx 54.8$. Therefore, the repairman needs to rent a bucket arm with a minimum length of about 55 feet.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally spaced from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot.

Enter your answers and work or explanations in the space provided.

A good estimate for the height of the building is 52.5 feet. It’s given that the door is 7.5 ft tall, and it covers 3 metal sheets, so each sheet is 2.5 feet high. Assuming that the metal sheets are of the same dimensions and 21 sheets in total by counting, we can figure out that the building is about 2.5x21, or 52.5 ft high.

The minimum bucket length is approximately 60 feet. Knowing that the angle bucket truck’s maximum angle is 70°, the angle formed with the building and the ground is 90° which makes the triangle formed a right triangle, the bucket’s arm is 6 feet off the ground, and the building is 52.5 feet tall, we can use trigonometry concepts to solve the problem. First, we need to acknowledge that 6 feet should be integrated into the height of the building because the triangle forms above the 6 foot line, so we should use 52.5 - 6, or 46.5 feet as the height. Sin 70° = \frac{46.5}{x}, where x is the hypotenuse length, or the length of the bucket arm. By solving for x we find that it equals to about 60 feet.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 feet tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck’s arm is 6 feet off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot. Explain your answer or show your work.

Enter your answers and work or explanations in the space provided.

The building is about 60 feet tall and i got this from how tall the door is and how many doors it would take to make the buildings hight.
A repairman plans to rent a bucket truck to repair the roof of a building. The diagram shows a bucket truck and the building.

The door of the building is 7.5 ft tall. Sheets of metal are horizontally placed on the outside of the building. The sheets of metal are equally placed from the bottom to the top of the building. A bucket truck's arm is 6 ft off the ground and its maximum angle is 70°.

- What is a best estimate for the height of this building? Explain your reasoning and any assumptions made.
- What is the minimum bucket arm length the repairman needs to rent to reach the roof? Round your answer to the nearest foot.

Enter your answers and work or explanations in the space provided.

The best estimate for the height of this building is 52.5 ft or greater. This is because the door is 7.5 ft tall, which is the approx. length of 3 metal strips. There are 7 rows of 3 metal strips so $7 \times 7.5 = 52.5$.

The minimum bucket arm length that the repairman needs to rent to reach the roof is 49 ft.

To find this answer, you would subtract 6 from 52.5 because the height of the car is 6 ft. You are now left with 46.5. Now find the length needed by using sin.

\[
\sin 70 = \frac{46.5}{x}
\]

\[
x (\sin 70) = 46.5
\]

\[
x = \frac{46.5}{\sin 70}
\]

\[
x = 49.48, \text{ rounded to the nearest foot is, } 49 \text{ ft.}
\]
## Practice Set

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