

Clearance

Lesson five

Terminal Objective

Given a handout with real situational data, students will be able to calculate the possibility of a ship's passage underneath the Gerald Desmond bridge in the Port of Long Beach with 80% accuracy.

Content Standard Reference:

Algebra I

1.0 Students identify and use the arithmetic properties of subsets of integers and rational, irrational, and real numbers.

25.0 Students use properties of the number system to judge the validity of results, to justify each step of a procedure, and to prove or disprove statements.

25.1 Students use properties of numbers to construct simple, valid arguments (direct and indirect) for, or formulate counterexamples to, claimed assertions.

25.2 Students judge the validity of an argument according to whether the properties of the real number system and the order of operations have been applied correctly at each step.

Materials

Clearance Powerpoint

Time Required

1 class

Introduction of Lesson

Anticipatory Set:

The primary channel leading to the majority of offloading docks in the interior of the Port of Long Beach is spanned by the Gerald Desmond Bridge. The bridge was originally built in 1968 with plenty of clearance for shipping vessels to pass underneath. Today ships are being built larger and larger, and the ability for some ships to pass underneath is becoming impossible. What sorts of calculations need to happen before a ship is cleared to pass?

Student Objective:

Given real situational data, the student will be able to calculate the possibility of a ship's passage underneath the Gerald Desmond bridge in the Port of Long Beach.

Purpose:

- To raise interest in the Port of Long Beach
- To apply basic algebra skills and logical reasoning to a real situation with real data
- To raise interest in the importance of math in everyday life

Lesson

Input

Provide students with background on the Gerald Desmond Bridge.

Structural Type: Arch bridge / suspended deck

Function/usage: Road bridge connects the Ports of Long Beach and Los Angeles with the I-710.

Lesson cont'd

Span:	5,134 ft.
Built:	1968 (replacing the previous pontoon bridge)
Length:	1,053 feet long
Highest point:	250 feet

157 feet of clearance above the water

The primary channel leading to the majority of offloading docks in the interior of the Port of Long Beach is spanned by the Gerald Desmond Bridge. The bridge was originally built in 1968 with plenty of clearance for shipping vessels to pass underneath. Today, ships are being built larger and larger, and the ability for some ships to pass underneath the bridge is becoming impossible.

Students will calculate whether a ship can pass under the Gerald Desmond bridge given the ship's dimensions.

A typical ship's dimensions:

Length - bow to stern

Width - widest part of the ship

Depth - height of the hull taken from the lowest part under the water

TEUs - number of 20-foot containers the ship holds

Modeling

Can the Hanjin Amsterdam cargo ship pass under the Gerald Desmond Bridge?

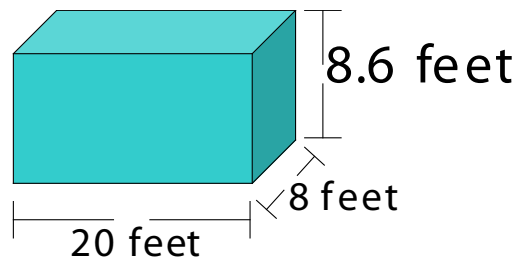
Ship:	Hanjin Amsterdam
Length:	279 meters
Width:	40 meters
Depth:	14 meters
TEUs:	5,618 - stacked 5 high

Lesson cont'd

What information given is needed to calculate total height?

Answer: Depth and the number of stacked TEUs

What is the height of a TEU?



What is the total height of the stacked TEUs?

$$\frac{5 \text{ TEUs}}{1} \cdot \frac{8.6 \text{ feet}}{1 \text{ TEU}} = 43 \text{ feet}$$

We now have feet and meters. We cannot combine unlike terms, so...

Convert depth from meters to feet:

$$\frac{14 \text{ meters}}{1} \cdot \frac{3.28 \text{ feet}}{1 \text{ meter}} = 45.9 \text{ ft.}$$

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ 45.9 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ 43 \text{ feet} \end{array} = 88.9 \text{ feet}$$

Will it clear the Gerald Desmond Bridge which has 157 feet of clearance?

YES!

Modeling

Can the Neptune Amber cargo ship pass under the Gerald Desmond Bridge?

Lesson cont'd

Ship: Neptune Amber
Length: 231 meters
Width: 32.2 meters
Depth: 12.5 meters
TEUs: 2,314 – stacked 6 high

What is the total height of the stacked TEUs?

$$\frac{6 \text{ TEUs}}{1} \cdot \frac{8.6 \text{ feet}}{1 \text{ TEU}} = 51.6 \text{ feet}$$

We now have feet and meters. We cannot combine unlike terms, so...

Convert depth from meters to feet:

$$\frac{12.5 \text{ meters}}{1} \cdot \frac{3.28 \text{ feet}}{1 \text{ meter}} = 41 \text{ feet}$$

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ \hline 41 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ \hline 51.6 \text{ feet} \end{array} = 92.6 \text{ feet}$$

Will it clear the Gerald Desmond Bridge which has 157 feet of clearance?

YES!

Check for Understanding

- 1) To determine whether a ship will pass under a bridge, the length of the ship is needed. **Answer:** False
- 2) When calculating the total height of the TEUs, the number of TEUs stacked above the ship's rail must be counted. **Answer:** True

Lesson cont'd

Modeling

Can the Zim Atlantic cargo ship pass under the Gerald Desmond Bridge?

Ship:	Zim Atlantic
Length:	253.7 m
Width:	32.2 m
Depth:	19.2 m
TEUs:	3,429 – stacked 8 high

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ \hline 63 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ \hline 68.8 \text{ feet} \end{array} = 131.8 \text{ feet}$$

Will it clear the Gerald Desmond Bridge which has 157 feet of clearance?

YES!

Modeling

Can the MSC Texas Majuro cargo ship pass under the Gerald Desmond Bridge?

Ship:	MSC Texas Majuro
Length:	321 m
Width:	42.8 m
Depth:	20.2 m
TEUs:	8,238 – stacked 8 high

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ \hline 66.3 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ \hline 68.8 \text{ feet} \end{array} = 135.1 \text{ feet}$$

Will it clear the Gerald Desmond Bridge which has 157 feet of clearance?

YES, but it is getting pretty tight...

Lesson cont'd

Modeling

This is one of the largest vessels currently in existence.

Length: 320 m
Width: 41 m
Depth: 29 m
TEUs: 7 high above rail

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ \hline 95.1 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ \hline 60.2 \text{ feet} \end{array} = 155.3 \text{ feet}$$

Will it clear the Gerald Desmond Bridge which has 157 feet of clearance?

Eeeeeeking by! Is it worth the risk?

Check for Understanding

Think, pair, share:

- 1) Think: What is one thing that was different about this example (vessel #5)?
- 2) Pair: Take turns telling your partner what was different.
- 3) Share: One person will be called on to share with the group.

Modeling

This is another very large vessel:

Length: 327 m
Width: 41.8 m
Depth: 32.2 m
TEUs: 6 high above rail

Lesson cont'd

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ 105.6 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ 51.6 \text{ feet} \end{array} = 157.2 \text{ feet}$$

Will it clear the Gerald Desmond Bridge at 157 feet of clearance?

NO!

Modeling

Let's try an even bigger ship.

Ship:	OOCL Long Beach SX Class Vessel
Length:	323.2 m
Width:	43 m
Depth:	38.8 m
TEUs:	8,000 + - stacked 7 high above rail

$$\begin{array}{r} \text{Depth of} \\ \text{the hull} \\ 127.3 \text{ feet} \end{array} + \begin{array}{r} \text{Height of the} \\ \text{stacked cargo} \\ 60.2 \text{ feet} \end{array} = 188.1 \text{ feet}$$

Will it clear the Gerald Desmond Bridge at 157 feet of clearance?

NO!

Closure

- In your notes, list the steps used today to determine whether or not a ship will be able to pass under a bridge.
- Check your list with your partner.
- Add any steps to your list that you feel are missing.

Extension Activities

How do tide changes affect the ability of ships to pass under the Gerald Desmond Bridge?

See “Tide Table Handout” or go to the following website for real time information: <http://www.saltwatertides.com/cgi-local/california.cgi>

Extreme low tide: -1.1 feet

Extreme high tide: 7.2 feet

How would high tide affect the passage of ships under the Gerald Desmond Bridge?

Answer: High tide would shorten the clearance by 7.2 feet to 149.8 ft.

Which vessels would be affected? Make a table to support your claim.

Vessel #	Height in feet	Passage under bridge (157 feet)	Height added to tide in feet	Effect of passage
Vessel #1	92.6	yes	99.8	same
Vessel #2	114.7	yes	121.9	same
Vessel #3	131.8	yes	139	same
Vessel #4	135.1	yes	142.3	same
Vessel #5	155.3	yes	162.5	will not pass
Vessel #6	157.2	no	164.4	same
Vessel #7	188.1	no	195.3	same

Vessel 5 would be affected where it was not before.

Write a statement in your notes describing the effect of high tide on ships passing under a bridge.

How would low tide affect the passage of vessels under the Gerald Desmond Bridge?

Extension Activities cont'd

Which vessels do you imagine would be most affected? Why?

Answer: Low tide would change the depth of the water. The heaviest vessels would be most affected because they sit further below the water line than a lighter ship.

Handout

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Container Ship Clearance Handout

Solve

Directions:

Calculate the following vessel clearance heights and determine whether or not they would be able to pass under the Gerald Desmond Bridge.

1 meter = 3.28 feet
TEU height = 8.6 feet
Gerald Desmond Bridge clearance = 157 feet

- | | |
|--|--|
| 1. Hull depth: 26 meters
TEUs above deck: 7 | 1. Clearance height _____
Will it clear the bridge? _____
If high tide is 7 feet? _____
If low tide is -1 foot? _____ |
| 2. Hull depth: 26 meters
TEUs above deck: 8 | 2. Clearance height _____
Will it clear the bridge? _____
If high tide is 7 feet? _____
If low tide is -1 foot? _____ |
| 3. Hull depth: 29.5 meters
TEUs above deck: 7 | 3. Clearance height _____
Will it clear the bridge? _____ |

4. Hull depth: 90 feet
TEUs above deck: 9

If high tide is 7 feet? _____
If low tide is -1 foot? _____

4. Clearance height _____
Will it clear the bridge? _____
If high tide is 7 feet? _____
If low tide is -1 foot? _____

5. Hull depth: 30 meter
TEUs above deck: 5

5. Clearance height _____
Will it clear the bridge? _____
If high tide is 7 feet? _____
If low tide is -1 foot? _____

ANSWERS

Lesson five

Container Ship Clearance Answers



- | | |
|--|--|
| 1. Hull depth: 26 meters
TEUs above deck: 7 | 1. Clearance height 145.5
Will it clear the bridge? yes
If high tide is 7 feet? yes
If low tide is -1 foot? yes |
| 2. Hull depth: 26 meters
TEUs above deck: 8 | 2. Clearance height 154.1
Will it clear the bridge? yes
If high tide is 7 feet? no
If low tide is -1 foot? yes |
| 3. Hull depth: 29.5 meters
TEUs above deck: 7 | 3. Clearance height 157
Will it clear the bridge? no
If high tide is 7 feet? no
If low tide is -1 foot? yes |
| 4. Hull depth: 90 feet
TEUs above deck: 9 | 4. Clearance height 167.4
Will it clear the bridge? no
If high tide is 7 feet? no
If low tide is -1 foot? no |
| 5. Hull depth: 30 meters
TEUs above deck: 5 | 5. Clearance height 141.4
Will it clear the bridge? yes
If high tide is 7 feet? yes
If low tide is -1 foot? yes |