Case Study II: Optimizing Cargo Hold Volume on a Lunar Mission

Engage: The lesson will begin with the teacher discussing the history of lunar exploration. The teacher will show the footage of Neil Armstrong walking on the Moon. The teacher will discuss the Apollo mission. The teacher will ask the students to think of the supplies and scientific instruments required for the mission. The students will compose a list of items needed for a successful mission via a class discussion.

Explore: The teacher will begin a class discussion on the topic of volume. The class will be divided into groups of four and each group will be asked to calculate how many matchboxes (5 cm x 1 cm x 8 cm) would fit in a shoebox (25 cm x 20 cm x 30 cm). The groups will be asked to justify their logic and present the findings to the class.

After reporting their findings to the class each group will be given a shoebox and a supply of matchboxes in order to validate their findings (alternatively, any larger box and a set of smaller boxes may be used). In this hands-on activity the students will be able to prove or disprove their earlier findings. Finally, the groups will construct the KWL chart in order to identify what the group has learned and what questions it may have.

Explain: After concluding the class discussion mentioned above and completing the KWL chart, the teacher will explain to the students that the volume of a three-dimensional rectangular shape can be computed by multiplying its three dimensions: $v = lwh$.

Most importantly, however, the teacher will explain to the class the best way to approximate the number of units that would fit in a larger space is to divide the volume of that space by the volume of each unit.

Extend: To further students' understanding of how to optimize a cargo hold volume for different containers, the students will be asked to complete a case study worksheet (of appropriate difficulty level) where they will consider various scenarios of cargo hold volume optimization.

Once the case studies are completed, the students will work in the computer lab where they will practice optimizing cargo volume holds using the WTD tool. By using the WTD tool, the students will be able to drag and drop containers of different sizes in the cargo hold of a spacecraft in order to optimize its capacity. The teacher will circulate and offer individual help as needed.

Evaluate: As students complete the case studies, their finding shall be presented to the class. The students will submit their Findings Sheets and they will be posted on the classroom walls. The teacher will proceed with re-teaching or enrichment as needed after analyzing students' work.

Lunar Habitat II

Case Study II
Level A
Student Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A or Type B containers would fit in the cargo hold.

Lunar Habitat II

Case Study II
Level B
Student Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A and Type B containers are required to fill 50% of the cargo hold with each container type.

Lunar Habitat II

Case Study II
Level C
Student Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A and Type B containers are required to fill the cargo hold if the requirement is to have the equal amount of containers of each type.

Lunar Habitat II

Case Study II
Level A
Teacher Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A or Type B containers would fit in the cargo hold.

$V_{CargoHold} = 3 \text{ x } 8 \text{ x } 5 = 120\ (m^3)$

$V_{TypeA} = 1 \text{ x } 1 \text{ x } 1 = 1\ (m^3)$

$V_{TypeB} = 3 \text{ x } 1 \text{ x } 1 = 3\ (m^3)$

Therefore, the cargo hold would have a capacity of 120 Type A containers ($V_{CargoHold}$ / V_{TypeA}) or 40 Type B containers ($V_{CargoHold}$ / V_{TypeB}).

Lunar Habitat II

Case Study II
Level B
Teacher Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A and Type B containers are required to fill 50% of the cargo hold with each container type.

$V_{CargoHold} = 3 \text{ x } 8 \text{ x } 5 = 120\ (m^3)$

$V_{TypeA} = 1 \text{ x } 1 \text{ x } 1 = 1\ (m^3)$

$V_{TypeB} = 3 \text{ x } 1 \text{ x } 1 = 3\ (m^3)$

Therefore, the cargo hold would have a capacity of 60 Type A containers ($0.5V_{CargoHold} / V_{TypeA}$) or 20 Type B containers ($0.5V_{CargoHold} / V_{TypeB}$). Remember to multiply the volume of the cargo hold by 0.5.

Lunar Habitat II

Case Study II
Level C
Teacher Worksheet

Optimizing Cargo Hold Volume on a Spacecraft

You are the load manager for the next lunar mission. The cargo hold of the spacecraft is three meters tall, eight meters long, and five meters wide. There are two container types used for this mission. Type A container is a cube with each side being one meter long. Type B container is three meters long, one meter tall, and one meter wide.

Your task is to determine how many Type A and Type B containers are required to fill the cargo hold if the requirement is to have the equal amount of containers of each type.

$V_{CargoHold} = 3 \text{ x } 8 \text{ x } 5 = 120\ (m^3)$

$V_{TypeA} = 1 \text{ x } 1 \text{ x } 1 = 1\ (m^3)$

$V_{TypeB} = 3 \text{ x } 1 \text{ x } 1 = 3\ (m^3)$

Let N be the number of Type A containers and Type B containers required to fill the cargo hold. Therefore, $N\ V_{TypeA} + N\ V_{TypeB} = V_{CargoHold}$ or $1N + 3N = 120$ ($4N = 120$; $N = 30$). Therefore, 30 containers of each type would be required to fill the cargo hold.

Lunar Habitat II
Case Study II
Findings Sheet

Name(s): ________________
Level: ________________
Period: ________________
Date: ________________

Directions: Fill out this sheet completely and turn it in with all work to your teacher.

Question	Answer	Reasoning
Question 1(level A): How many Type A or Type B containers would fit in the cargo hold?		
Question 2 (level B): How many Type A and Type B containers are required to fill 50% of the cargo hold with each container type?		
Question C (level C): How many Type A and Type B containers are required to fill the cargo hold if the requirement is to have the equal amount of containers of each type?		