Mathematics with Airlift Missions

Students will practice applying mathematical equations and problem solving skills as they learn the basics of the storage capability of the C-17 and C-5 cargo planes.

Learning Objectives:

The students will:
- Practice applying equations and problem solving skills while learning about USAF airlift capability
- Learn about the dynamics of solving problems while working as a team
- Explain the steps used by their team to identify and solve math scenarios/problems given to the whole class
- Explain why their team's solutions are valid/correct

Purpose:

Students will learn about the capabilities of the C-17 and C-5. They will learn about the weight, size, and height capacity of each cargo airplane and how they stow items. Students will learn how to solve real world problems involving storage capabilities. They will apply mathematical skills to solve these problems and find out what is the best solution.

Background:

The C-17 "Globemaster III" is currently the U.S. Air Force's newest, most versatile cargo aircraft to enter the airlift force. The C-17 is capable of rapid strategic delivery of troops and all types of cargo to main operating bases or directly to small, austere airfields. It can also perform tactical airlift and airdrop missions or transport litters and ambulatory patients during aeromedical evacuations. A crew of three (pilot, copilot and loadmaster) operates the C-17, which can carry about 170,000 pounds of cargo and 18 loaded supply pallets. Another cargo plane of the U.S. Air Force is the C-5. The C-5M "Super Galaxy" is a strategic transport aircraft and is the largest aircraft in the USAF inventory. Its primary mission is to transport cargo and personnel for the Department of Defense (similar to the C-17). The C-5M can carry a load of 281,001 pounds with 36 loaded supply pallets. Each of these cargo planes use a special pallet that is used by the Air Force to take cargo all over the world. It is called a 463L pallet. The 463L pallet is 88 inches x 108 inches x 2.25 inches thick. These pallets are used for an array of supplies and humanitarian aid. They are made of aluminum with a soft wood or fiberglass core and framed on all sides by aluminum rails.

Grade Level: 5 - 6

Ohio Learning Standards/Mathematics (2017)

Algebra
5.OA.2: Write simple expressions

Number & Operations
5.NBT.4: Use place value to round decimals
5.NBT.5: Fluently multiply numbers using algorithm
5.NBT.7: Solve real-world problems using the four main mathematical operations
6.NS.3: Fluently add, subtract, multiply, divide multi-digit decimals

Measurement & Data
5.MD.1: Know U.S. customary measurement units

Ratios & Proportional Relationships
6.RP.2.c.: Find a percent of a quantity

Materials Required:

- Pencils
- Worksheet
- Paper
- Calculators

Procedure:

A. Warm-up

   1. Review information regarding C-17 "Globe master III" and C-5M "Super Galaxy."

   2. Within your classroom, you may wish to make an outline of the perimeter of a 463L pallet (using string or tape) so students can grasp just how big a 463L really is (88 inches x 108 inches x 2.25 inches thick). Explain that one pallet can hold 10,000 pounds and that a C-17 can hold 18 of them within its cargo bay/floor.

   3. Divide students into teams of four or five students (depending on the size of the class).

B. Activity

   1. Student should receive a worksheet, pencils, and a calculator.

   2. Each exercise should take about 15 minutes to complete.

   3. Review each question after the 15 minutes and discuss problem solving methods.

   4. Discuss incorrect answers and how this might occur.

Assessment/Evaluation:

The students should be evaluated on class participation, listening skills and ability to follow verbal instructions, and ability to work well as a team.

Resources:

C-17 "Globemaster III"

https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195851/boeing-c-17-globemaster-iii/

https://www.af.mil/About-Us/Fact-Sheets/Display/Article/1529726/c-17-globemaster-iii/#:~:text=With%20a%20payload%20of%20164%2C900,74%20Mach).

https://duotechservices.com/9-facts-about-the-c-17-globemaster

C-5M "Super Galaxy"

https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104492/c-5-abc-galaxy-c-5m-super-galaxy/#:~:text=The%20C%2D5M%2C%20with%20a,limited%20only%20by%20crew%20endurance.

https://yeahmotor.com/aero/c-5-galaxy-facts/

https://www.lockheedmartin.com/en-us/products/c-5.html

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Exercise Worksheet

Exercise 1:

Your team has to load food, water and tents for humanitarian aid to help people in Honduras who were hit by a big earthquake and flooding. How many pallets of each commodity will they need to load onto their aircraft for transport to Central America?

Given –

Food = 39,000 pounds

Water = 57,000 pounds

Tents = 60,000 pounds

One pallet can hold 10,000 pounds

C-17 "Globemaster III" total cargo (weight) capacity = 160,000 pounds, 18 pallets

Show all work below

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Exercise 2:

Your team has to load bales of hay on a C-17 to feed starving cattle that have been stranded in a blizzard in Kansas. Each bale of hay weighs 80 pounds and is 22" wide by 36" long and can be stacked 10 high on a pallet. There is still a 160,000 pound and 18 pallet maximum restriction. How many bales will fit on the first layer of a pallet? How much weight is on each pallet? How much weight is in the entire humanitarian shipment? And how many pallets will be required?

Given –

Bale of hay = 80 pounds, 22" wide by 36" long

Pallet dimensions = 88 inches x 108 inches x 2.25 inches

C-17 "Globemaster III" total cargo (weight) capacity = 160,000 pounds, 18 pallets

One pallet can hold 10,000 pounds

Show all work below

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Exercise 3:

There has been a terrible natural disaster, and it has effected several countries in Asia. The team must load water, food, medical supplies, blankets and tents into a C-5M "Super Galaxy" to provide relief to the suffering people in these countries. The base supply depot has already loaded each pallet with these needed items. How many of each palletized commodity they will need to load onto the C-5M?

Given –

Each loaded pallet = 7,900 pounds (regardless of weight)

Must be 11 pallets of water = 86,900 pounds

Food needs to be 2x number of pallets, other than medical supplies, blankets, and tents

C-5 payload/cargo capacity = 285,000 pounds, 36 pallets

One pallet can hold 10,000 pounds

Show all work below

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Exercise 4:

In continuation from Exercise 3: there has been a terrible natural disaster, and it has effected several countries in Asia. Team must load water, food, medical supplies, blankets and tents into a C-5M "Super Galaxy" to provide relief to the suffering people in these countries. The base supply depot has already loaded each pallet with these needed items. What is percentage of each palletized commodity based on the 36 maximum pallets they will need to load onto the C-5M?

Given –

11 pallets of water

10 pallets of food

5 pallets per other commodity

C-5 payload/cargo capacity = 285,000 pounds, 36 pallets in total

One pallet can hold 10,000 pounds

Show all work below

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Answer Sheet to Exercises

Exercise 1:

Your team has to load food, water and tents for humanitarian aid to help people in Honduras who were hit by a big earthquake and flooding. How many pallets of each commodity will they need to load onto their aircraft for transport to Central America?

Given –

Food = 39,000 pounds

Water = 57,000 pounds

Tents = 60,000 pounds

C-17 "Globemaster III" total cargo (weight) capacity = 160,000 pounds, 18 pallets

Show all work below

Food $= \dfrac{39,000}{10,000} = 3.9 = $ **~4 pallets**

Water $= \dfrac{57,000}{10,000} = 5.7 = $ **~6 pallets**

Tents $= \dfrac{60,000}{10,000} = $ **6 pallets**

Total weight = 39,000 + 57,000 + 60,000 = 156,000

Total = 16 pallets, with a total weight of 156,000 pounds (works in terms of load capacity)

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Exercise 2:

Your team has to load bales of hay to feed starving cattle that have been stranded in a blizzard in Kansas. Each bale of hay weighs 80 pounds and is 22" wide by 36" long and can be stacked 10 high on a pallet. There is still a 160,000 pound and 18 pallet maximum restriction. How many bales will fit on the first layer of a pallet? How much weight is on each pallet? How much weight is in the entire humanitarian shipment? And how many pallets will be required?

Given –

Bale of hay = 80 pounds, 22" wide by 36" long

Pallet dimensions = 88 inches x 108 inches x 2.25 inches

C-17 "Globemaster III" total cargo (weight) capacity = 160,000 pounds, 18 pallets

Show all work below

Multiply dimensions to find amount:

22" * 4 = 88" max pallet dimension

36" * 3 = 108" max pallet dimension

4 * 3 = 12 bales per pallet on first layer

12 bales and can be stacked ten high:

12 * 10 = 120 bales per pallet

120 bales * 80 pounds = 9,600 pounds

$\frac{160,000}{9,600}$ **= 16.6667 = 16 pallets (rounding up goes over 160,000 limit)**

16 pallets * 9,600 pounds = 153,600 pounds

Exercise 3:

There has been a terrible natural disaster, and it has effected several countries in Asia. Team must load water, food, medical supplies, blankets and tents into a C-5M "Super Galaxy" to provide relief to the suffering people in these countries. The base supply depot has already loaded each pallet with these needed items. How many of each palletized commodity they will need to load onto the C-5M?

Given –

Each loaded pallet = 7,900 pounds (regardless of weight)

Must be 11 pallets of water = 86,900 pounds

Food needs to be 2x number of pallets, other than medical supplies, blankets, and tents

C-5 payload/cargo capacity = 285,000 pounds, 36 pallets

Show all work below

Each pallet = 7,900 pounds * 36 max pallets = <mark>284,400 pounds</mark>

Does not exceed 285,000 pound

11 pallets of water – 36 max = 25 pallets left

Food 2x more than other three commodities

2x = 25

2x + x + x + x = 25

5x = 25

$$x = \frac{25}{5} = 5$$

<mark>Food = 2x = 2 * 5 = 10 pallets</mark>

<mark>Other commodities = 5 pallets</mark>

Exercise 4:

In continuation from Exercise 3: there has been a terrible natural disaster, and it has effected several countries in Asia. Team must load water, food, medical supplies, blankets and tents into a C-5M "Super Galaxy" to provide relief to the suffering people in these countries. <u>The base supply depot has already loaded each pallet with these needed items.</u> What is percentage of each palletized commodity based on the 36 maximum pallets they will need to load onto the C-5M?

Given –

11 pallets of water

10 pallets of food

5 pallets per other commodity

C-5 payload/cargo capacity = 285,000 pounds, 36 pallets in total

Show all work below

Water = 11 pallets $= \frac{11}{36} = 0.3055 * 100 =$ ==**~30.5%**==

Another way to solve

$\frac{36}{100} * \frac{11}{x} = 36x = 1,100$

$x = \frac{1,100}{36} =$ ==**~30.5%**==

Food = 10 pallets $= \frac{10}{36} = 0.2778 * 100 =$ ==**~27.78%**==

Another way to solve

$\frac{36}{100} * \frac{10}{x} = 36x = 1,000$

$x = \frac{1,000}{36} =$ ==**~27.78%**==

Medical supplies, blankets, and tents = 5 pallets $= \frac{5}{36} = 0.1388 * 100 =$ ==**~13.88%**==

Another way to solve

$\frac{36}{100} * \frac{5}{x} = 36x = 500$

$x = \frac{500}{36} =$ ==**~13.88%**==

Total = 30.5% + 27.78% + (3*13.88%) = 99.92% = ~100%

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