NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

Mathematics with Airlift Missions – Fuel Capacity

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

Learning Objectives:

The students will:

- Practice applying 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 long they can fly. Students will learn how to solve real world problems involving fuel capacity. 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. With this payload and an initial cruise altitude of 28,000 feet (8,534 meters), the C-17 has an unrefueled range of approximately 2,400 nautical miles. 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. It can fly 2,150 nautical miles, offload, and fly to a second base 500 nautical miles away from the original destination, all without aerial refueling. With aerial refueling, the aircraft's range is limited only by crew endurance.

Grade Level: 5 - 7

Ohio Learning Standards/Mathematics (2017)

Algebra
5.OA.2: Write simple expressions

Number & Operations (-fractions)
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
5.NF.2: Solve problems involving addition & subtraction of fractions
5.NF.3: Interpret a fraction
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.3.c.: Find a percent of a quantity

Geometry
7.G.4: Work with circles

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. Review the formula for circumference of a circle and the circumference of the earth.

$$\text{Circumference of a circle} = 2\pi r$$

$$\text{Circumference of the earth} = 24{,}901 \text{ miles} = \sim 25{,}000 \text{ miles}$$

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

B. Activity

1. Students should receive an example and exercise worksheet, pencils, and a calculator.
2. Review the example question with the students.
3. Students then have 20 minutes to complete the exercise.
4. Review each question when finished and discuss problem solving methods.
5. 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/References:

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

https://www.boeing.com/defense/c-17-globemaster-iii/

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

Example Worksheet

How many times would a C-5M "Super Galaxy" need to be refueled in order to travel completely around the world (using the rounded number for the earth's circumference)?

Assumptions: C-5M is flying with a small load, full tank of gas and can go approximately 6,250 miles before needing to be refueled.

Find out how many tanks of fuel the C-5M needs:

Divide 25,000 by 6,250 $\frac{25,000}{6,250}$ = 4 times

Knowing that there was a full tank to start, we need to refuel *3 times*

$(\frac{25,000}{6,250})$ – 1 = **3 times**

Express, in fractions/decimals/percentages/degrees, the distance represented in each "leg" of the trip:

a. Through leg 1 of the C-5's trip: A: ¼ / .25 / 25% / 90 degrees

b. Through leg 2 of the C-5's trip: A: 2/4 or ½ / .50 / 50% / 180 degrees

c. Through leg 3 of the C-5's trip: A: ¾ / .75 / 75% / 270 degrees

d. Through leg 4 of the C-5's trip: A: 4/4 or 1.00 / 100% / 360 degrees

How many gallons of jet fuel this C-5 burned to go three-fourths (3/4) of the way around the earth, if one complete refueling takes 51,450 gallons of fuel?

3 legs of the trip so:

51,450 gallons * 3 = **154,350 gallons in total**

Exercise Worksheet

How many times would a C-17 "Globemaster III" need to be refueled in order to travel completely around the world (using the rounded number for the earth's circumference)?

Given –

C-17 cargo = 160,000 pounds

C-17's range with full fuel tanks = 2,400 Nautical Miles

a. Statute Miles = 5,280 feet

b. Nautical Miles equal Statute Miles plus 796 feet (or approximately 15% more) = 6,076 feet

c. 2,400 nautical x 1.15 = approximately 2,760 Statute Miles

Show all work below

Express, in fractions/decimals/percentages/degrees, the distance represented in each refueling:

Show all work below

If our C-5 (with no cargo) burns 206,000 gallons of jet fuel to circle the globe, and our C-17 (fully loaded) uses 244,000 gallons, how much more fuel is used by the C-17 (expressed in a percentage)?

Show all work below

Exercise Answer Worksheet

How many times would a C-17 "Globemaster III" need to be refueled in order to travel completely around the world (using the rounded number for the earth's circumference)?

Given –

C-17 cargo = 160,000 pounds

C-17's range with full fuel tanks = 2,400 Nautical Miles

d. Statute Miles = 5,280 feet

e. Nautical Miles equal Statute Miles plus 796 feet (or approximately 15% more) = 6,076 feet

f. 2,400 nautical x 1.15 = approximately 2,760 Statute Miles

Show all work below

Find out how many tanks of fuel the C-5M needs -

Divide 25,000 by 2,760 $\frac{25,000}{2,760}$ = 9.0579 times

Knowing that there was a full tank at the beginning, we refuel *8 times*

$(\frac{25,000}{2,760}) - 1$ = **9.0579 = ~8 times**

Express, in fractions/decimals/percentages/degrees, the distance represented in each refueling:

Show all work below

a. Through leg 1 of the C-17's trip: A: 1/9 / .11 / 11% / 40 degrees

b. Through leg 2 of the C-17's trip: A: 2/9 / .22 / 22% / 80 degrees

c. Through leg 3 of the C-17's trip: A: 3/9 / 1/3 / .33 / 33% / 120 degrees

d. Through leg 4 of the C-17's trip: A: 4/9 / .44 / 44% / 160 degrees

e. Through leg 5 of the C-17's trip: A: 5/9 / .56 / 56% / 200 degrees

f. Through leg 6 of the C-17's trip: A: 6/9 or 2/3 / .67 / 67% / 240 degrees

g. Through leg 7 of the C-17's trip: A: 7/9 / .78 / 78% / 280 degrees

h. Through leg 8 of the C-17's trip; A: 8/9 / .89 / 89% / 320 degrees

i. Through leg 9 of the C-17's trip: A: 9/9 or 1 / 1.00 / 100% / 360 degrees

If our C-5 (with no cargo) burns 206,000 gallons of jet fuel to circle the globe, and our C-17 (fully loaded) uses 244,000 gallons, how much more fuel is used by the C-17 (expressed in a percentage)?

Show all work below

$\frac{(244{,}000-206{,}000)}{206{,}000} = 0.1845$

0.1845 * 100 = **18.45%**

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C-5M “Super Galaxy”

https://www.af.mil/News/Photos/

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C-17 Globemaster III

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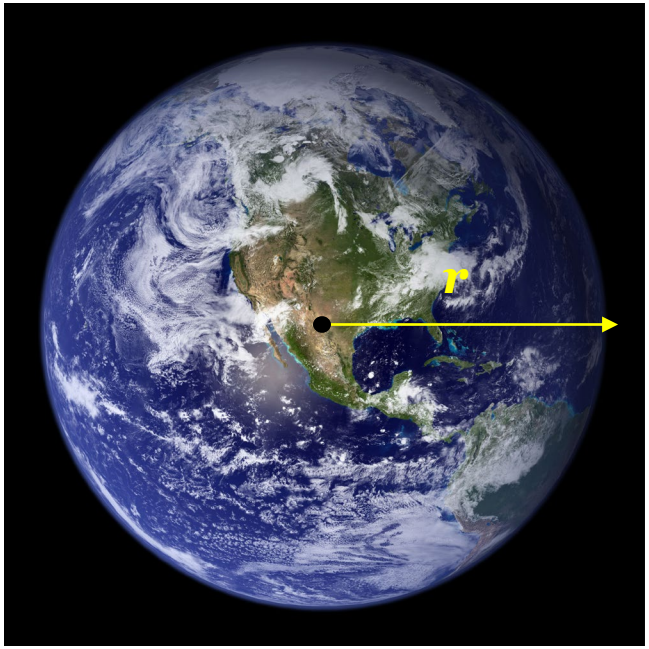
Circumference of the World



Approximately 24,901 miles

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Example: The Math for Flying Around the World

C-5M "Super Galaxy"

http://bashfuladventurer.com/wp-content/uploads/2013/12/plane-around-the-globe.jpg

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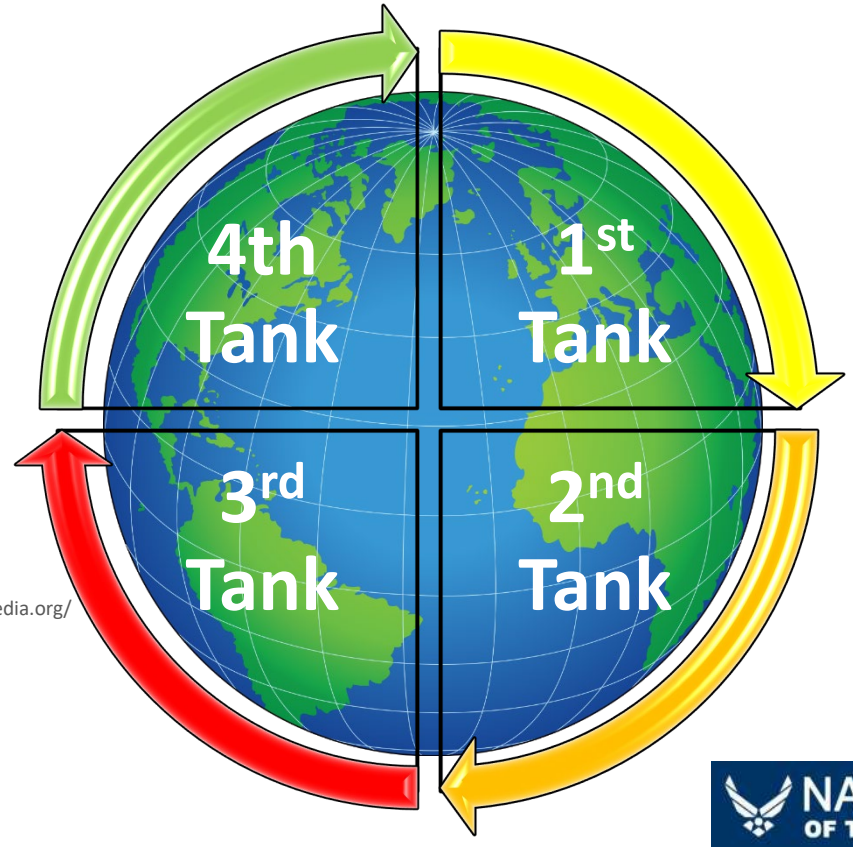
The Math for Flying Around the World

C-5M "Super Galaxy"



https://upload.wikimedia.org/

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The Math for Flying Around the World

C-17 “Globemaster III”

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