CARGO PLANES

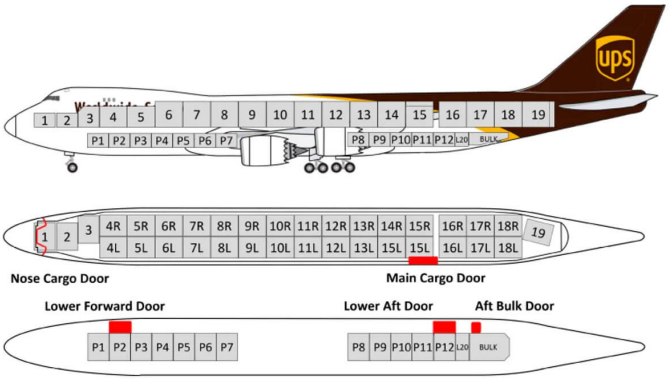
STEM Challenge 2021

PROGRAM DESCRIPTION

Students will design, build, and test a cargo plane that can travel a minimum distance of one meter while carrying cargo. The challenge is to see who can carry the most weight the furthest distance. Be sure to check out the Expansion Activities and Careers sections at the end.

YOUR TASK

More than ever, the need to transport large amounts of cargo across the globe efficiently has increased rapidly. Cargo planes are designed to only carry goods (or cargo) without the need for passenger seats. Goods are carried in a huge storage space called the cargo hold, which can fill the entire length of the plane. Your challenge is to design the most efficient cargo plane that can also carry the largest capacity. Let's see who can make a plane to carry the most weight the furthest distance!



TIME

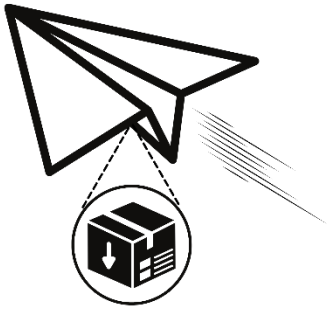
30 minutes – 45 minutes

ACTIVITIES

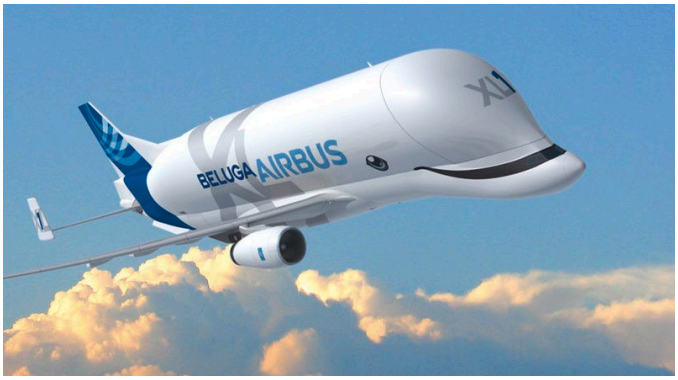
- **Introduction:** Learn vocabulary and key concepts relating to the exercise.
- **Activity 1:** *Construction* - Students will design and construct their cargo plane prototypes.
- **Activity 2**: *Testing* - Students will test their designs and record their data.
- **Activity 3:** *Analysis* - Students will evaluate their data.
- **Reflection Questions**: Students will review and form conclusions based on their findings.

MATERIALS

- Paper
- Tape
- Coins or Washers
- Paperclips
- Tape measure
- A digital or balance scale (optional)

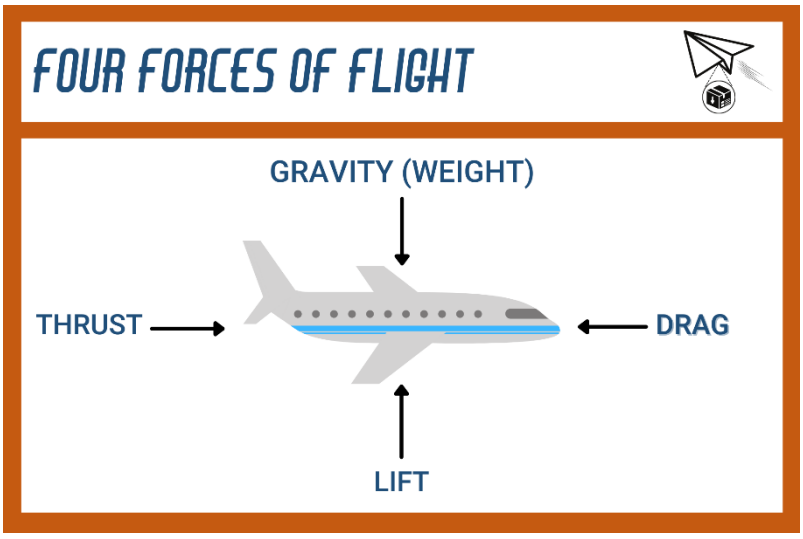


Introduction



Vocabulary

- Force – A push or a pull.
- Gravity – The force that pulls matter together. Acceleration due to gravity equals 9.8m/s^2 on Earth.
- Bernoulli's Principle - an increase in the speed of a fluid occurs simultaneously with a decrease in static pressure or a decrease in the fluid's potential energy (see Lift)
- Drag - the force that acts opposite to the direction of motion.
- Force - a push or pull upon an object resulting from the object's interaction with another object.
- Gravity - the force that attracts a body toward the center of the earth, or toward any other physical body having mass.
- Lift - the upward force that is created by the movement of air above and below a wing. Air flows faster above the wing and slower below the wing, creating a difference in pressure that tends to keep an airplane flying.
- Mass - the measurable amount of matter in an object
- Thrust - the force that moves an aircraft in the direction of the motion. It is created with a propeller, jet engine, or rocket. Air is pulled in and then pushed out in an opposite direction.



Activity 1: *Construction*

Now that you have reviewed some vocabulary and key concepts, it is time to create your cargo plane prototype!

1) Before construction, students should use the space below to plan the design of their cargo plane.
2) Students can add to their sketch the areas where they would place weight and hypothesize why these might be the best places to add cargo too.
3) Students may use the materials listed to construct the cargo plane, but there are no requirements regarding the design or structure.

Activity 2: *Testing*

In this exercise, you will test your cargo plane prototype with and without cargo. You will need to throw the plane from the same area each time to ensure accurate and consistent results. Use the charts on page 4 to record your trial data. If needed, use the space below to record more trials and choose your 5 best to analyze.

Without Cargo

1) *Optional:* Weigh the cargo plane prototype on the scale. Record on the appropriate chart.
2) Students must throw their cargo plane by hand from the same designated area each time. Be as consistent as possible so that data is accurate.
3) Record 5 throws ***without cargo*** (coins or washers) on the chart below.
4) **SUCCESSFUL** cargo planes - the plane lands safely (right side up), and over 1 meter away from the throw line.
5) **UNSUCCESSFUL** cargo planes - the plane lands upside down, and/or does not fly far enough.

With Cargo

1) Repeat the trial above but this time with added cargo weight. Continue adding weight until unsuccessful.
2) Record 10 **SUCCESSFUL** throws ***with cargo*** on the designated chart.

PLANE PERFORMANCE - NO CARGO

Collect your data

Trial	Distance (m)	Adjustments?
1		
2		
3		
4		
5		

Record the weight of your cargo plane here (optional):

PLANE PERFORMANCE - WITH CARGO

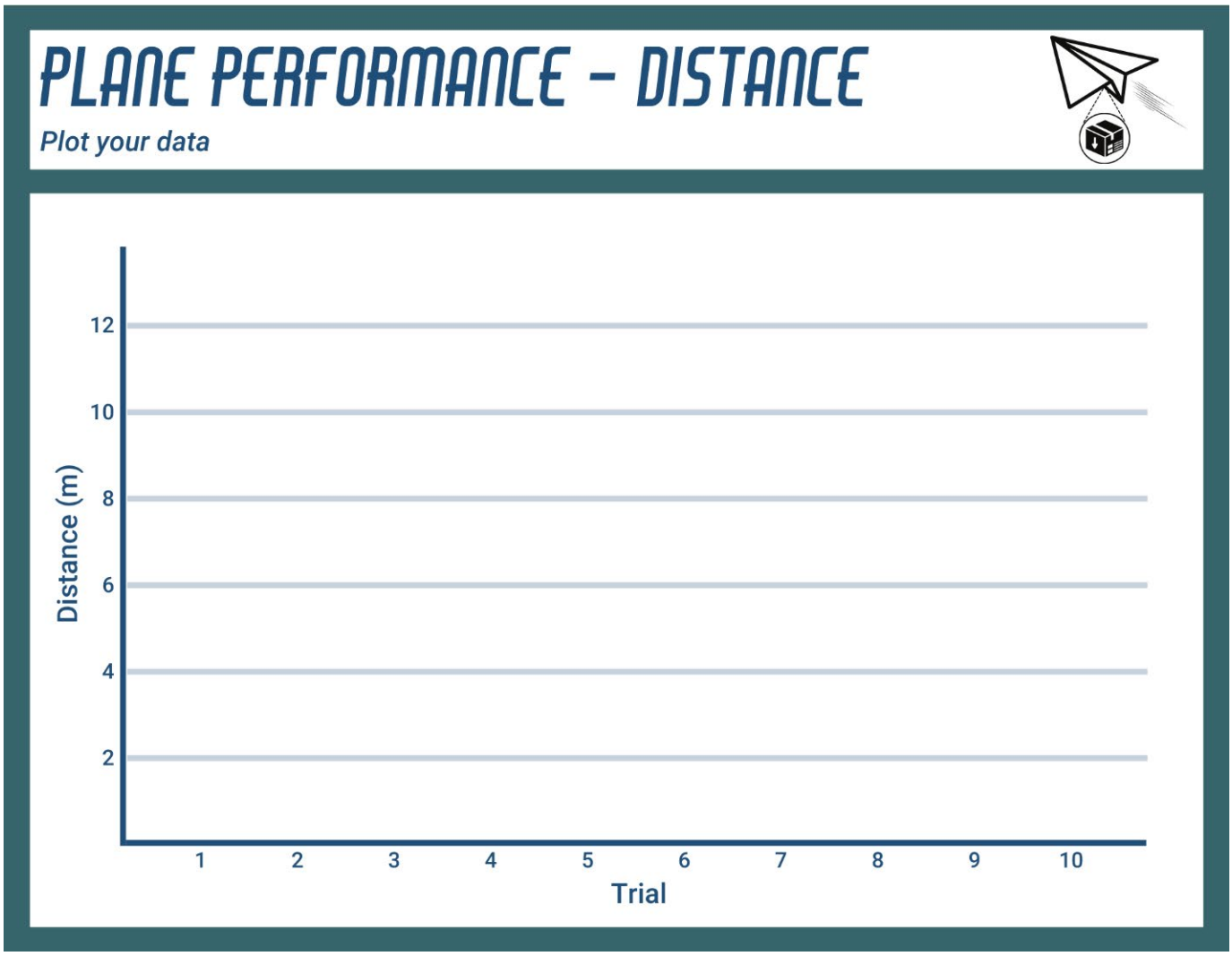
Collect your data

Trial	Distance (m)	Mass Added*	Adjustments?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

*If scale unavailable write down amount of objects used (i.e. # or $)

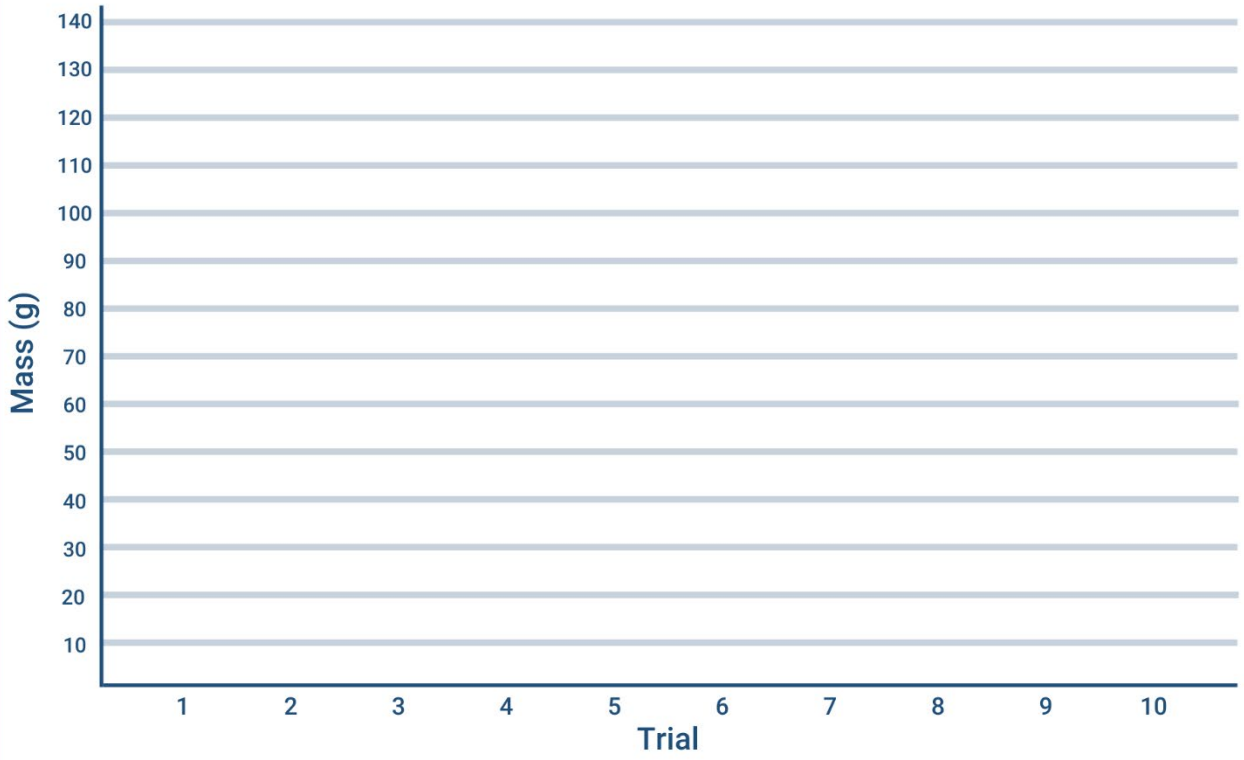
Activity 3: *Analysis*

In this exercise, you will graph your data. If you did more than 10 trials, choose your 10 best to record. If you were able to measure mass, go ahead and plot that data on the second graph. You can also change the y axis to amount of items you used instead! Afterwards, you will analyze the data with some reflection questions.



PLANE PERFORMANCE – MASS

Plot your data



REFLECTION QUESTIONS

1) What was the most your plane could carry? The least? How did this correlate with the distance it traveled?

2) What worked well? What didn't work well?

3) Overall, was your cargo plane prototype successful? Why or why not?

4) What changes could you make to improve your design?

Reflection Questions Continued

5) What two forces are causing the plane to fall? How are we countering the effects?

6) If you were to design a cargo plane for an aerospace company, what would you focus on? An example would be you wish to make a plane that is fuel efficient!

Expansion Activities

- Calculate the average distance of the trials.

  Average Distance = Sum of Distance / Number of Trials

- Find the final velocity of the prototype. You will need to time your flight. Initial Velocity is **zero** because this is a falling object. Note that this does not consider air resistance!

  Final Velocity (m/s) = Initial Velocity (m/s) + Acceleration (9.8 m/s^2) * Time (__s)

Careers

Below are some STEM careers that you could do one day!

Industrial Engineer– Industrial Engineers use their knowledge of science, math, and engineering to improve or create better processes for others to work in/with. This could mean designing new manufactory facilities for cargo planes that are more efficient and safer, to coming up with a system to improve communication between different divisions in a plant.

Aircraft Technician – Aircraft Technicians work on the electrical and mechanical aspects of cargo planes to check that everything is working properly and fixing what is not. This job helps to ensure a safe flight for the cargo and crew aboard. You would be required to know how the cargo plane works and to work hands-on with airplane parts and the tools needed to fix them.

Aerospace Engineer – Aerospace Engineering focuses on developing and manufacturing new aircrafts. For cargo planes, this means designing planes that are more efficient, as well as safer for the crew and cargo. This job requires a lot of math, science, and computer skills, but is also a very creative STEM career.

Pilot – Pilots of cargo planes are very similar to airline pilots, though they fly cargo and not passengers. Like many aviation careers, pilots use math when in their jobs. They use math to determine things like their speed and location. While a lot of this is done by computers now, understanding how it is done and being able to do it yourself is still important to pilots.

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