

## UPS STEM Challenge 2020

# AIRDROP!

### PROGRAM DESCRIPTION

Students will design and build a parachute prototype and cargo cushion that can safely land a package (plastic egg). Be sure to check out the [Expansion Activities](#) and [Careers](#) sections at the end.

### YOUR TASK

UPS is releasing “AirDrop”, a new delivery method that delivers packages by air. UPS needs your help in designing a parachute prototype and a cargo cushion that will be released from an AirDrop Aircraft to safely deliver packages.

### 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 parachute prototypes and cargo cushions.
- **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 (SOME OF THESE ITEMS WILL BE IN YOUR STEM CAREER DAY BAG)

- Popsicle sticks
- Plastic bag
- Tape
- String or yarn
- Timer (phone or stopwatch)
- Pipe cleaners
- Plastic egg
- Scissors
- Cardboard
- Cotton balls
- Rubber bands
- Water
- Packing Peanuts
- Bubble wrap
- Pencil
- Clothespin
- Tape measure
- Any other building materials you can think of!



INTRODUCTION

# VOCABULARY



Air Resistance	The drag force caused by air acting in the opposite direction that an object is moving. It is the push against gravity's pull on a parachute.
Atmosphere	The gases held by gravity around Earth and other planets.
Force	A push or a pull
Gravity	The force that pulls matter together. Acceleration due to gravity equals $-9.8\text{m/s}^2$ on Earth.
Speed	The rate at which an object moves (Speed=Distance/Time).

## Bonus Advanced Vocabulary

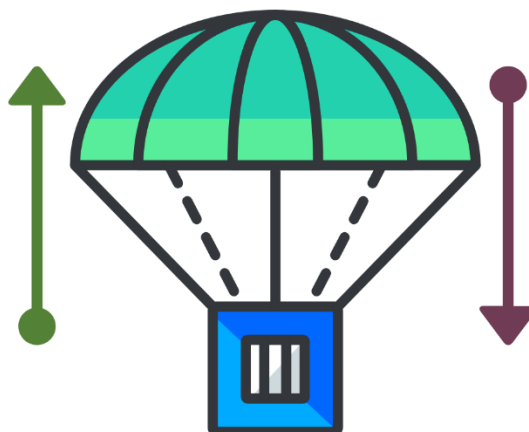
Acceleration	The rate at which velocity changes (Acceleration=Distance/Time <sup>2</sup> ). The only ways to accelerate are a change in speed, a change in direction, or both.
Velocity	Velocity is speed but with direction. It is the rate at which an object moves.

# MOVEMENT OF OBJECTS

*Acceleration*



Acceleration due to air resistance acting on the parachute slows the descent of the object.



Acceleration due to gravity acting on the parachute moves the parachute and package down.

## ACTIVITY 1: CONSTRUCTION

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

1. Before construction, students may use the space below to plan the design of their parachute prototype and cargo cushion.
2. Students may use the materials listed to construct the parachute prototype and cargo cushion, but there are no requirements regarding the design or structure.
3. The package (plastic egg) must be filled with water. Place a piece of tape over any holes that the egg has so that water doesn't leak out! Fill the top of the egg with water (approximately 3 tablespoons or 50 grams) and close with the bottom. Note: you may NOT seal the egg shut with tape. A package is considered "damaged" if it cracks open and spills water during descent or landing.
4. Students must drop their parachute prototype by hand from an elevated height of approximately 2 meters (~6.5 feet). Practice safety and ask an adult to help you with this part. Be as consistent as possible so that data is accurate.
5. Record 5 drop times with a stopwatch (most phones have this feature) on the chart below.
6. **SUCCESSFUL** parachute prototypes and cargo cushions - the package lands safely, and no water spills out
7. **UNSUCCESSFUL** parachute prototypes and cargo cushions - the package is damaged, during descent or landing.


Answer the following questions after you finish building.

1. What materials did you use to construct your parachute prototype and why?
2. What materials did you use to construct your cargo cushion and why?

**ACTIVITY 2: TESTING**

In this exercise, you will test your parachute prototype and cargo cushion. Note that you may want to do this outside or on a waterproof flooring in case your package (egg) opens. Use the chart below to record your trial data. If needed, use the space below to record more trials and choose your 5 best to analyze.

## PARACHUTE PERFORMANCE

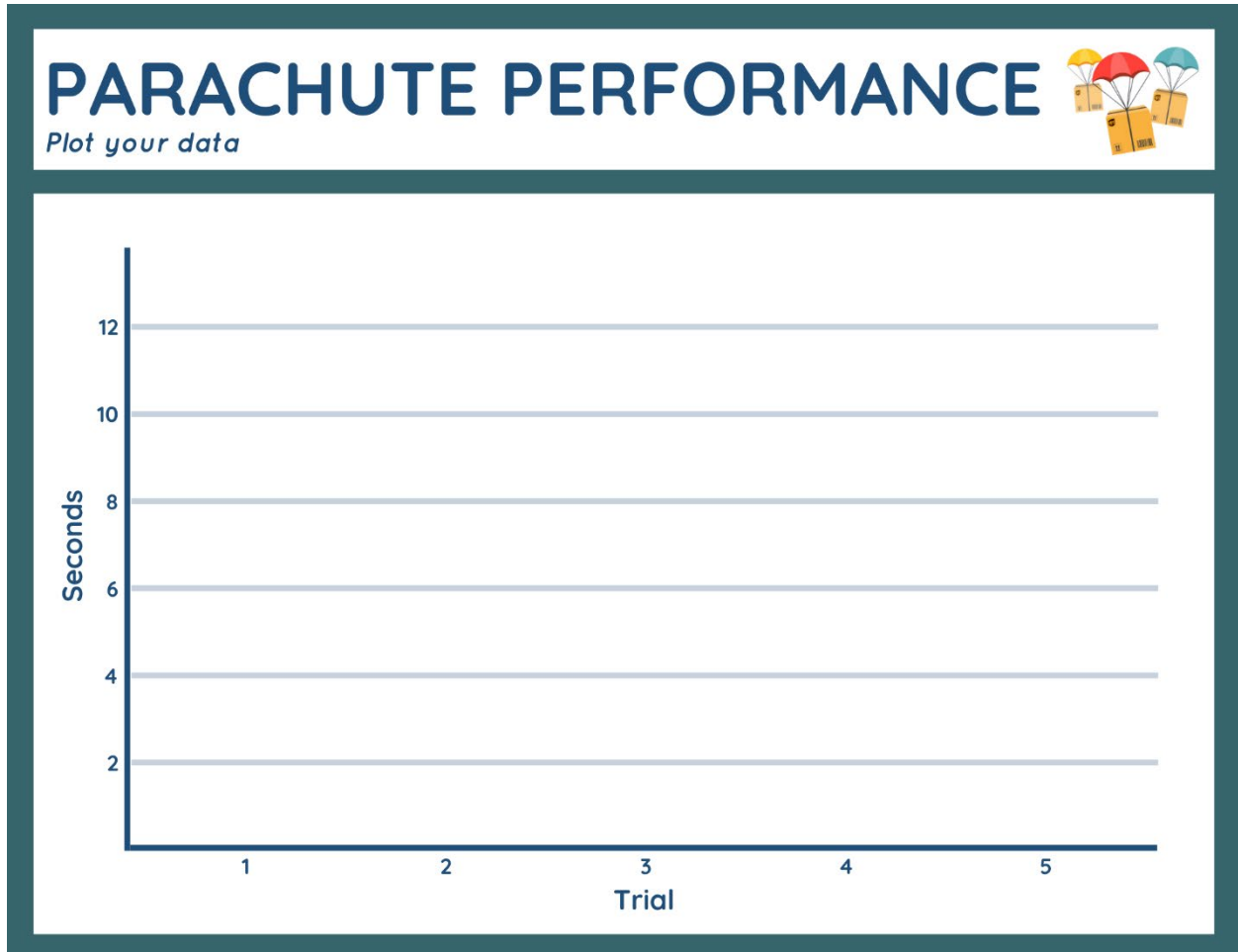


*Collect your data*

Trial	Time (s)	Successful Landing?	Adjustments?
1			
2			
3			
4			
5			

### ACTIVITY 3: ANALYSIS

In this exercise, you will graph your data. If you did more than 5 trials, choose your 5 best to record. Afterwards, you will analyze the data with some reflection questions.



### REFLECTION QUESTIONS

1. What was your longest time to land your package? The shortest?
2. What worked well? What didn't work well?
3. Overall, was your parachute prototype and cargo cushion successful? Why or why not?
4. What changes could you make to improve your design?

## REFLECTION QUESTIONS CONTINUED

5. If UPS were to create the “Airdrop” program in reality, what are some limitations of the model we have made for them? (*Hint: Our prototype is much smaller than what a regular sized package normally is*)
6. If humans were to live on the Moon or even Mars, what would we have to consider in order to deliver packages with Airdrop? (*Hint: Is gravity the same on all planets? Why or why not?*)

## EXPANSION ACTIVITIES

- Students can design the new Airdrop Aircraft that would deliver their package!
- Bring on the math! Calculate the average time of the trials.  
Average Time = Sum of Times / Number of Trials
- Find the final velocity of the prototype. You will need to use your average time from the above formula. 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<sup>2</sup>) \* Time (\_\_\_s)

## CAREERS

Below are some careers that you could do one day!

Package Handler – Package Handlers are responsible for loading and unloading packages from a warehouse or delivery vehicle. Their job requires lots of physical labor. Package Handlers must make sure that packages are delivered safely and efficiently.

Warehouse Manager – A Warehouse Manager keeps the warehouse organized and makes sure that packages are received, sorted, and distributed correctly and quickly. Warehouse Managers must also lead and schedule employees to make sure warehouse operations run smoothly.

Drone Pilot – A Drone Pilot is responsible for safely operating and driving drone machines, or UAS (unmanned aerial systems). Drone Pilots conduct safety tests, monitor the weather, operate cameras and other drone equipment, and make sure the drone’s systems are working properly.

Parachute Riggers – Parachute Riggers design and construct airdrop platforms, cushioning materials, and airdrop vehicles to ensure the safe delivery of packages. Parachute Riggers are also responsible for loading and unloading any cargo or packages on an aircraft.

**Special thanks to our sponsor, UPS!**