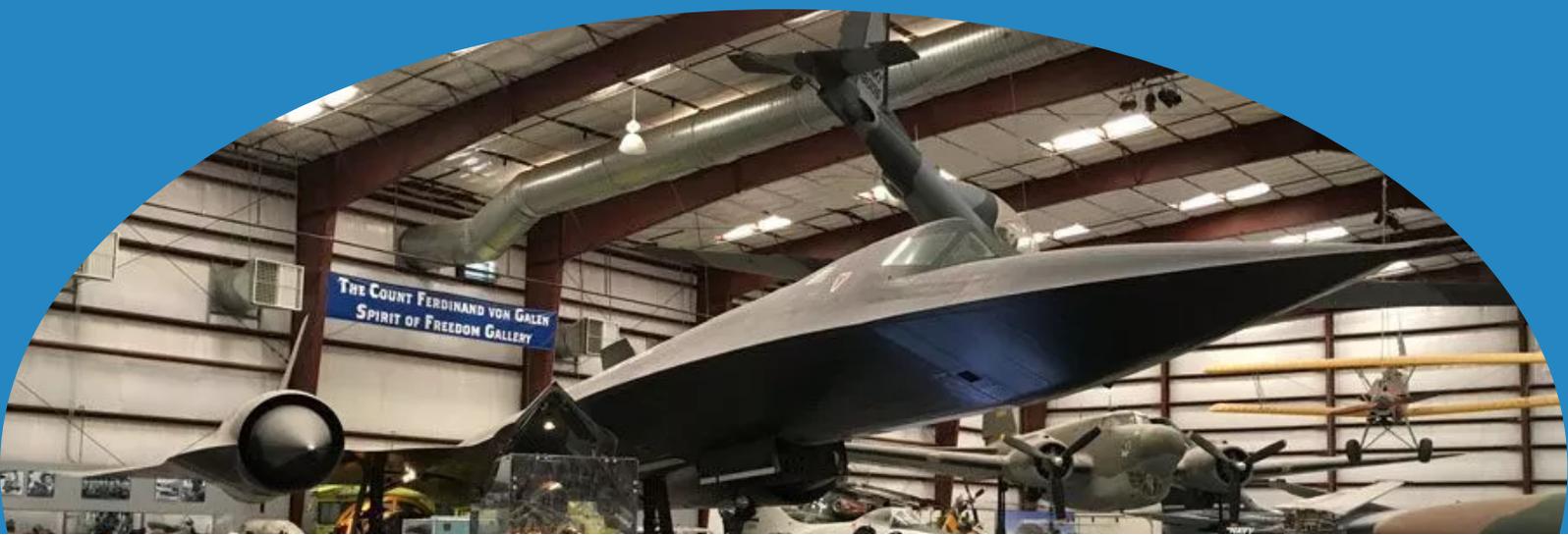




FORCES OF FLIGHT

PIMA AIR AND SPACE MUSEUM



FORCES OF FLIGHT

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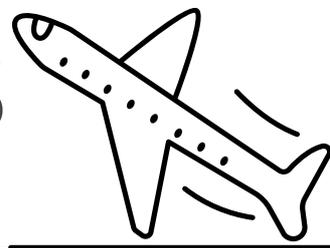
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ARIZONA STATE SCIENCE STANDARDS

· 6TH GRADE- HIGH SCHOOL

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THE FOUR FORCES OF FLIGHT



Introduction

People have been fascinated by the idea of human flight since observing flight in birds and other animals. From Greek mythologies to Leonardo de Vinci to the Wright Brothers' first airplane, we can trace the development of human flight that has led to the modern-day, fixed-wing airplane. But how do these planes stay in the air?

Force

A force is a push or a pull on an object that can change the object's motion. This happens when two objects interact with each other.

Sir Isaac Newton came up with three laws of motion that are all involved in flight.

1. An object in motion will stay in motion and an object at rest will stay at rest unless acted on by an unbalanced force.
2. Force is equal to mass times acceleration.
3. For every action, there is an equal and opposite reaction.

There are four forces involved in a plane flying that follow Newton's Laws of Motion.

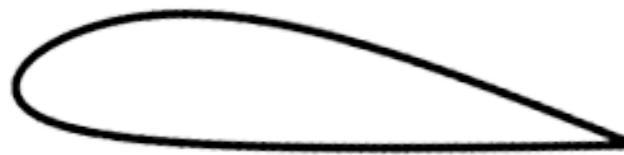
Forces of Flight

The first is gravity. Gravity is the force that pulls objects toward Earth. Any object that has mass also has a gravitational pull (yes, that means you too!). The more mass an object has, the larger its gravitational pull will be. We just don't notice the pull of gravity from other objects because Earth's gravity is so much stronger since the Earth has a much larger mass compared to everything on Earth. If gravity is pulling down on airplanes, then according to Newton, there must be a force that works opposite to gravity in order for a plane to fly.

That upward force is called lift. Lift in planes is generated by the shape of the wing that causes differences in air pressure above and below the wings.

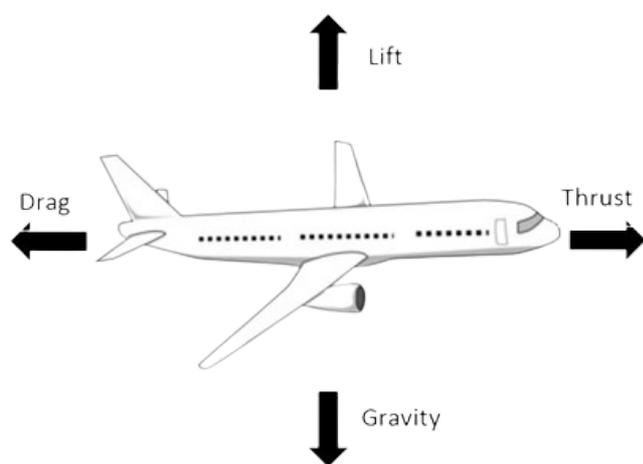
THE FOUR FORCES OF FLIGHT

Pressure is a force that pushes, so the more air molecules that push on the wing the higher the pressure is. The type of wing shape, called an airfoil, allows the air to travel faster above the wing airfoil than below it.



Bernoulli's Principle explains that as the speed of a moving fluid (in this case, air) increases, the pressure within the fluid decreases. This means the faster moving air has less pressure than the slower moving air, so there is more pressure being exerted underneath the wing than there is above the wing, causing lift.

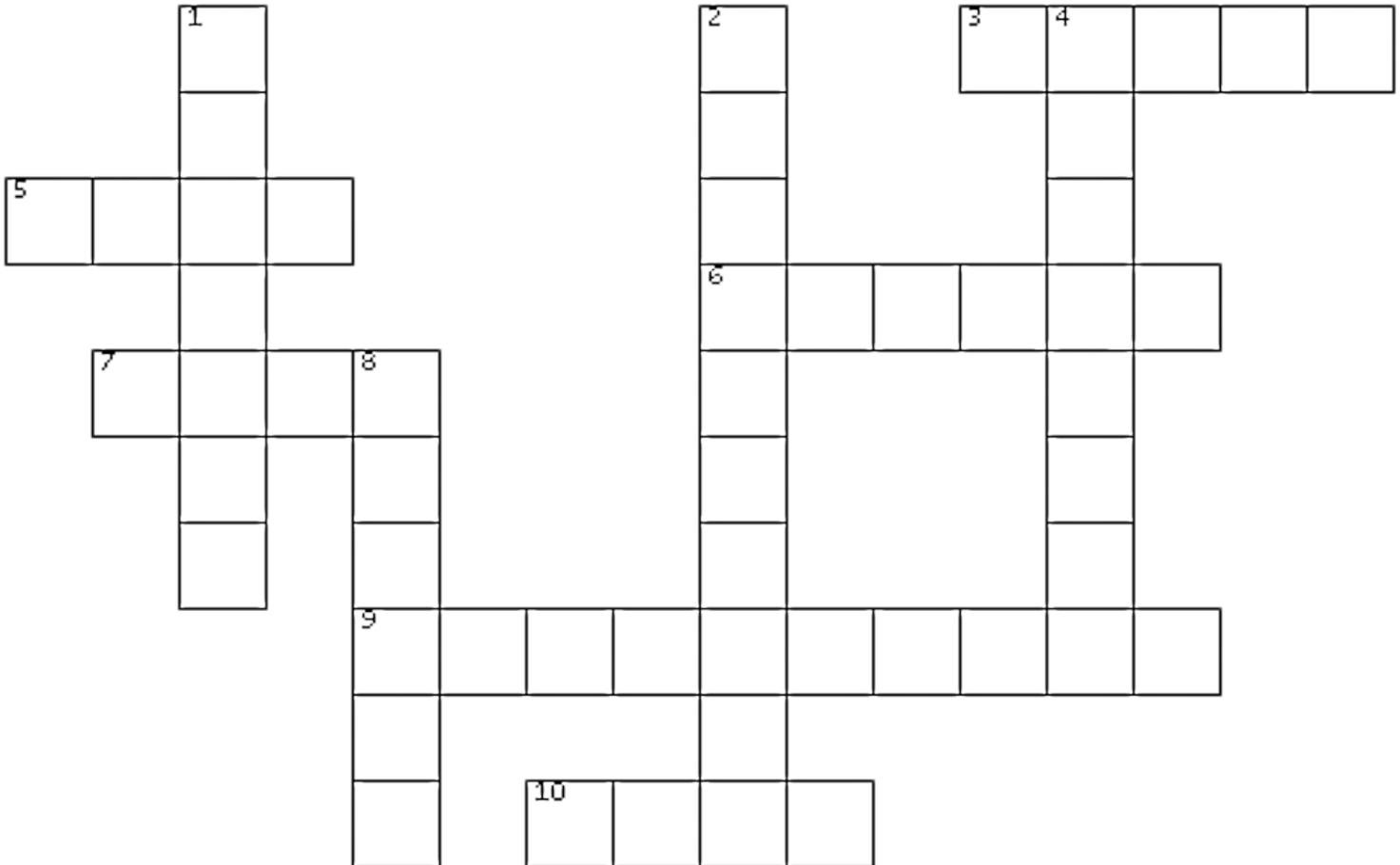
We've examined how a plane can overcome gravity, but how does a plane move forward through the air? Air is made up of molecules that are spaced far apart from each other, and those molecules exert a force called drag on objects moving through the air. Drag is also known as wind resistance. The faster an object travels through the air, the more drag it will experience. Think about holding your hand out a car window when it is moving. When the car goes faster, you can feel the increase in drag, the air molecules pushing against your hand. Thrust is the opposite of drag and allows an object to move forward through the air. In order for the plane to begin moving, thrust must be greater than drag. In an airplane, thrust is generated by a propeller, jet engine, or a rocket





CROSSWORD

USE THE VOCAB FROM THE READING TO FILL IN THE FOLLOWING CROSSWORD PUZZLE

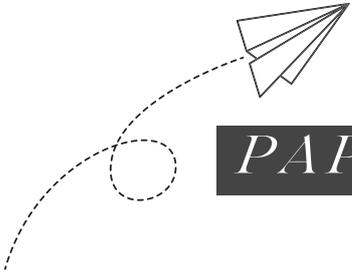


ACROSS

3. A PUSH OR PULL ON AN OBJECT THAT CAN CHANGE AN OBJECT'S MOTION
5. A FORCE EXERTED BY AIR MOLECULES THAT PUSHES AGAINST AN OBJECT
6. SIR ISAAC _____ CAME UP WITH THREE LAWS OF MOTION
7. A FORCE GENERATED BY THE SHAPE OF AN AIRPLANE'S WING THAT CAUSES DIFFERENCES IN AIR PRESSURE ABOVE AND BELOW THE WING
9. AN OBJECT AT REST WILL STAY AT REST AND AN OBJECT IN MOTION WILL STAY IN MOTION UNLESS ACTED ON BY AN _____ FORCE
10. FORCE IS EQUAL TO _____ TIMES ACCELERATION

DOWN

1. A FORCE THAT PULLS OBJECTS TOWARDS EARTH
2. THE PRINCIPLE THAT STATES THAT AS THE SPEED OF A MOVING FLUID INCREASES, THE PRESSURE DECREASES
4. FOR EVERY ACTION, THERE IS AN EQUAL AND _____ REACTION
8. A FORCE THAT ALLOWS AN AIRPLANE TO MOVE FORWARD THROUGH THE AIR



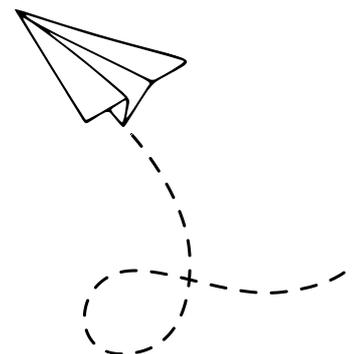
PAPER AIRPLANE CHALLENGE

Using what you've learned about the four forces of flight, you will make and test a paper airplane to see how far you can get it to fly. You may only use one sheet of copy paper: No tape, paperclips, or staples. Make sure your group's name is on the airplane. Answer the following questions after you test your airplane for the first time.

1. Did your paper airplane fly the way you thought it would? Why or why not?
2. What generates the thrust for your paper airplane?
3. How might you reduce drag on your airplane?
4. How might you change the wings to increase lift?

Make any changes you want to for your paper airplane. Follow your teacher's instructions for testing whose plane will go the farthest. After all the class has thrown their planes, answer the following questions.

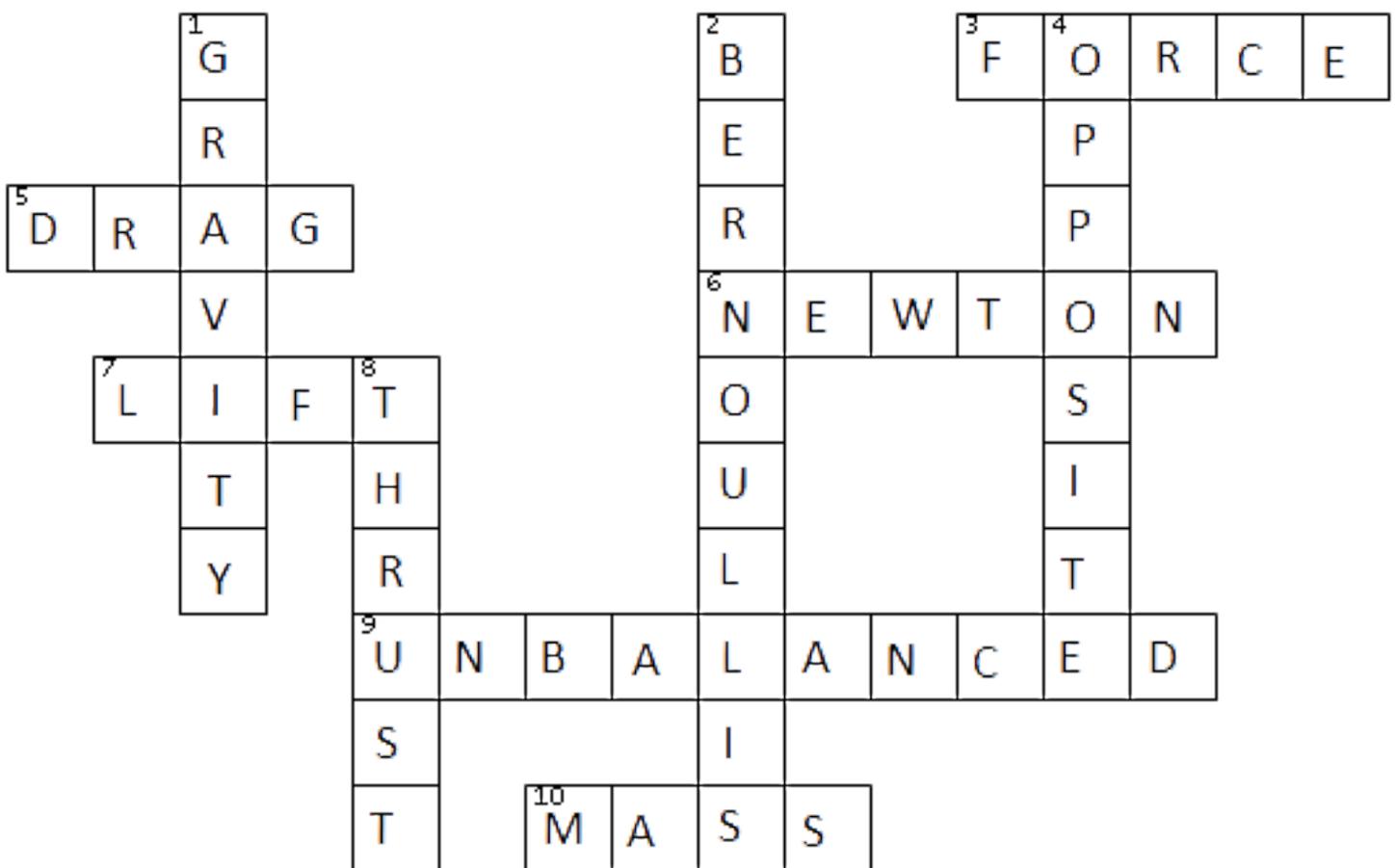
1. After seeing all the other group's planes, what would you change about your plane?
2. Besides distance, what else might be a good thing to define paper airplane success?



Four Forces of Flight Reading

Make sure each student or group has a copy of the Four Forces of Flight Reading. You can use this to introduce the concept of forces or to supplement previous material. Once they've finished reading, they can complete the vocab crossword puzzle. If you are using this packet as a stand-alone activity, and not part of a field trip package at the museum, move on to the Paper Airplane Challenge. Otherwise, the Paper Airplane Challenge can be a post-activity to be completed after the field trip.

Crossword Puzzle Answers



EXTENSION IDEAS: VOCAB FLASHCARDS

Paper Airplane Challenge

This activity requires a large space such as a gym, cafeteria, or hallway to fly and measure which group's airplane flies the farthest. Each group will need one or two sheets of plain copy paper to build their airplane. You can choose to provide templates for them to follow or allow them to create their own planes. Allow students one or two test flights so they can make adjustments to their planes and answer Questions 1-4.

For the challenge, have one group throw their plane and mark where it lands (not slides!). Have each group throw their plane.

Students can answer the post-flight questions as a class or in their individual groups. Question 1 possible answers: Fold the plane smaller, make the wings larger, make the plane longer, etc. Question 2 possible answers: fastest plane, which plane can carry the most amount of weight, which plane can stay in the air for the most amount of time.

Extension Ideas: Use a stopwatch and tape measure to calculate speed, add weight to the planes (paperclips or tape) to see if they still fly the same, test the angles planes are thrown

