IMHOTEP'S LEGACY ACADEMY

6.2 - Understanding Flight

Grade 6 Activity Plan

Reviews and Updates

6.2 Understanding Flight

Objectives:

1. To understand Bernoulli's Principle
2. To explain drag and how different shapes influence it
3. To describe how the results of similar and repeated investigations testing drag may vary and suggest possible explanations for variations.
4. To demonstrate methods for altering drag in flying devices.

Keywords/concepts: Bernoulli's Principle, pressure, lift, drag, angle of attack, average, resistance, aerodynamics

Curriculum outcomes: 107-9, 204-7, 205-5, 206-6, 301-17, 301-18, 303-32, 303-33.

Take-home product: Paper airplane, hoop glider

Segment	Details
African Proverb and Cultural Relevance (5min.)	“The bird flies, but always returns to Earth.” **Gambia**
Pre-test (10 min.)	Have any of you ever been on an airplane? Have you ever wondered how such a heavy aircraft can fly? Introduce Bernoulli’s Principle and drag. Show this video on Bernoulli’s Principle: https://www.youtube.com/watch?v=bv3m57u6ViE Note: To gain the speed so lift can be created the plane has to overcome the force of drag; they also have to overcome this force constantly in flight. Therefore, planes have been designed to reduce drag
Demo 1 (10 min.)	Use the students to demonstrate the basic properties of Bernoulli’s Principle.
Activity 2 (30 min.)	Students use paper airplanes to alter drag and hypothesize why different planes performed differently
Activity 3 (20 min.)	Students make a hoop glider to understand the effects of drag on different shaped objects.
Post-test (5 min.)	Word scramble.
Additional idea	https://www.amazon.com/PowerUp-Smartphone-Controlled-Paper-Airplane/dp/B00N8GWZ4M

Suggested Interpretation of Proverb
What comes up must come down

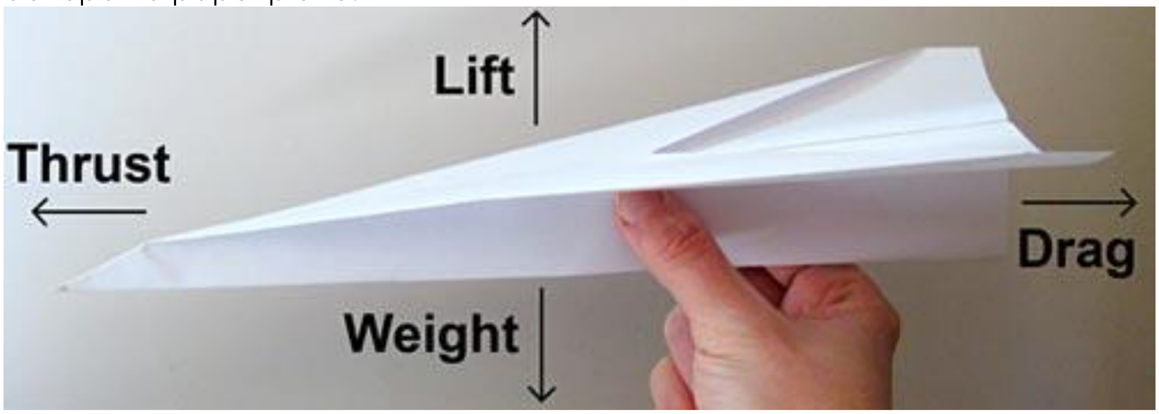
Background Information

Bernoulli's Principle
Daniel Bernoulli, an eighteenth-century Swiss scientist, discovered that as the velocity of a fluid increases, its pressure decreases. Bernoulli's principle applies to any fluid, and since air is a fluid, it applies to air. Bernoulli's principle for flight is that "airplanes fly because the pressure above the wing is smaller than the pressure below the wing."
Lift
Lift is the force that holds an aircraft in the air and can be explained using Bernoulli's Principle.
Drag
The type of drag that we are most familiar with is form drag. This is the resistance (or pushing) sensation you feel when you walk into the wind. It is caused by all of the air molecules running into your body. Form drag is dependant on the shape of an object, the cross-sectional area of an object, and the speed of an object. In the case of drag, the cross-sectional area is the area of an object that is facing the direction of its movement. For example, if you hold your hand out of a car's window with your palm down, you do not feel much push from the wind. If you turn your hand right, so that your palm faces the direction the car is moving, the wind will push your hand back much harder. This increase in resistance (push) is due to the increase of the cross sectional area of your hand, not the overall size of your hand.

Engineers often consider drag in designing things like airplanes and cars. They try to design these things as streamlined as possible. Streamlined means that the shape of the object, airplane or car can reduce the drag of the object (reduce the force opposing forward motion). This is why airplanes have rounded nose cones and why they pull up their landing gear after lift-off (to remove the wheels from being in the way and creating unnecessary drag).
Science of a paper plane
What allows the paper plane to glide through the air? And why does a paper plane finally land? To find out, we will talk about the science behind flying a paper plane and the different forces that get a paper plane to fly and land. These same forces apply to real airplanes, too. A force is something that pushes or pulls on something else. When you throw a paper plane in the air, you are giving the plane a push to move forward. That push is a type of force called thrust. While the plane is flying forward, air is moving over and under the wings and is providing a force called lift to the plane. If the paper plane has enough thrust and the wings are properly designed, the plane will have a nice long flight.

But there is more than lack of thrust and poor wing design that gets a paper plane to come back to Earth. As a paper plane moves through the air, the air pushes against the plane, slowing it down. This force is called drag. To think about drag, imagine you are in a moving car and you put your hand outside of the window. The force of the air pushing your hand back as you move forward is drag. Finally, the weight of the paper plane affects its flight and brings it to a landing. Weight is the force of Earth's gravity acting on the paper plane.

The picture below shows how all four of these forces, thrust, lift, drag, and weight, act upon a paper plane.



References:

http://www.aviation-for-kids.com/Lift.html
https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_airplanes/cub_airplanes_lesson05_activity1.xml
http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p046.shtml#background

Demo 1: Bernoulli's Principle in action

Purpose: To understand the basics on Bernoulli's Principle
Suggested format: This activity can also be done in a gym or a classroom if the gym is unavailable.

Procedure:

1) Find a clear space and make a large circle with masking tape.
   Option 2: Find an appropriate sized circle in the gym.
2) Have the students enter the circle and all start running at full speed without leaving the circle.
3) Have the students leave the classroom and all start running down the hallway in the same direction.
   Option 2: Have students gather at one side of the gym and run to the other side of the gym.
4) Return to the classroom.
5) Explain to the students that they represented atoms in a fluid and that their collisions represented pressure between those atoms.
6) Ask students what scenario led the most collisions between each other and why.

The science:
When the students were in the circle the speed of the group (the fluid) as a whole was zero and the pressure was high. When the students were all running as a group in the same direction the speed of the group (the fluid) as whole was high therefore the pressure was lower. This explains Bernoulli's theory on flight or why airplanes fly; the pressure above the wing is lower than the pressure above the wing therefore creating lift.
https://www.youtube.com/watch?v=aFO4PBolwFg

Reference:
http://www.aviation-for-kids.com/Lift.html

Activity 1: Testing Drag

Purpose: To explain drag and how different shapes influence it. To describe how the results of similar and repeated investigations testing drag may vary and suggest possible explanations for variations.

Suggested format: Students work in pairs (students should do some or all activities depending on the amount of time).

Item	**Quantity (10 students)**
2 litre soda bottle with the neck cut off or tall and wide glass jar	5
Pieces of clay or plasticine	20
Cooking oil	Enough to fill the soda bottles
Stopwatch	5
Thread	1 spool

Procedure:

1) **TO BE DONE BY MENTOR PRIOR TO ACTIVITY:** Cut pieces of clay into equal pieces and cut the pieces of thread long enough so that the clay can hit the bottom and the thread is still out of the oil.
2) Fill the jar almost to the top with cooking oil(cooking oil is used because it is more viscous than water so it is easier to see the effects of the drag.
3) Mould the clay into four different shapes (for example sphere, cube, teardrop shape or pyramid) around the thread.
4) Hold the first shape just above the surface of the oil, release, and start timing. Stop the timer when the shape hits the bottom.
5) Repeat this two more times and record the times.

Shape name	Trial 1	Trial 2	Trial 3	Average

6) Repeat steps 4 and 5 for the remaining shapes.
7) Calculate the average time for each shape and discuss why there were three different times for the trials. Why do we need to calculate the average?
8) Discuss the results and why one shape worked better than another.

Reference:
https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_airplanes/cub_airplanes_lesson05_activity1.xml

Activity 2: Testing Paper Airplanes

Purpose: To explain drag and how different wing shapes influence it. To test the performance of a flying device. To describe how the results of similar and repeated investigations testing drag may vary and suggest possible explanations for variations.

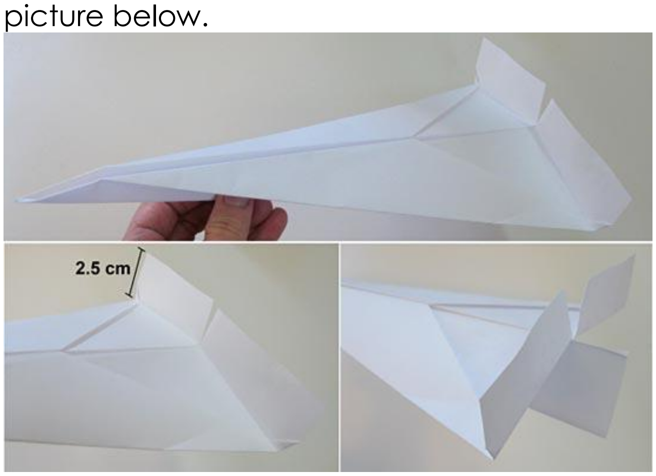
Suggested format: Students work in pairs (students should do some or all activities depending on the amount of time).

Item	Quantity (10 students)
8 ½" X 11" Paper	10
Clipboards	10
Measuring tape	1
Masking tape	1 roll

Procedure:

1) **TO BE DONE BY MENTOR PRIOR TO ACTIVITY:** Print off instructions for each type of paper airplane. From these websites:
   - http://www.foldnfly.com/0.html#The-Basic
   - http://www.foldnfly.com/1.html#Basic-Dart
   - http://www.foldnfly.com/3.html#The-Buzz
   - http://www.foldnfly.com/12.html#Water-Plane
   - http://www.foldnfly.com/27.html#Underside-Plane

2) Arrange the students in groups of two
   a. Have each pair of students pick a paper airplane
   b. Give each student a sheet of paper
   c. Each pair should fold the same airplane
3) Have one pair Use scissors to cut slits that are 2.5 cm long right where either wing meets the middle ridge
4) Fold up the 2.5 cm cut section on both wings so that these sections are at about a 90-degree angle from the rest of the wing, as shown in the picture below.



5) Go to a large area to fly the airplanes. The school gym or a hallway would be ideal. If you choose to fly them outside make sure it is not windy outside.
6) Make a starting line out of masking tape on the ground.
7) Have the first student fly their plane as far as they can from the starting line.
8) Measure how far the plane flew from the starting line and record it.
9) Repeat steps 9 and 10 two more times for this plane and calculate the average.
10) Repeat steps 9 to 11 for the rest of the students.
11) Have the students compare their results with their partner. Whose plane went farther? Why?
12) Write the results from each pair on the board and ask the students if they notice a pattern. Discuss the plane designs and why the fastest plane was the fastest and the slowest plane was the slowest etc.

The Science:
When the back of the plane is folded up it increases the area that the air has to push against, thus increasing the force of the drag.

Reference:
http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p046.shtml#summary

Activity 3: Testing the Aerodynamics of Hoop Gliders

Purpose: to test the aerodynamic qualities of hoop gliders so as to understand the effects of drag on different shaped objects

Suggested format: Students should do some or all activities depending on the amount of time.

Item	**Quantity (10 students)**
Scissors	10
Plastic drinking straw	10
Tape	5 rolls
Piece of Bristol board (or another type of sturdy paper)	10

Procedure

1. Cut the Bristol board into 3 separate pieces that measure 1 inch (2.5 cm) by 5 inches (13cm).
2. Take 2 of the pieces of paper and tape them together into a hoop as shown below. Be sure to overlap the pieces about half an inch (1 cm) so that they keep a nice round shape once taped.

3. Use the last strip of paper to make a smaller hoop, overlapping the edges like before.
4. Tape the paper loops to the ends of the straw as shown below. (notice that the straw is lined up on the inside of the loops).

5. Now hold the straw in the middle with the hoops on top and throw it in the air similar to how you might throw a dart, angled slightly up. With some practice you can get it to go farther than many paper airplanes.

The Science:
Can we really call that a plane? It may look weird, but you will discover it flies surprisingly well. The two sizes of hoops help to keep the straw balanced as it flies. The big hoop creates "drag" (or air resistance) which helps keep the straw level while the smaller hoop in at the front keeps your hoop glider from turning off course. Some have asked why the plane does not turn over since the hoops are heavier than the straw. Since objects of different weight generally fall at the same speed, the hoop will keep its "upright" position.

Reference:
http://sciencebob.com/the-incredible-hoop-glider/

Post Test

Print off the "Flight Word Scramble" worksheet on the following page.

Answers:

1.	UILENLOBR	BERNOULLI
2.	FLIT	LIFT
3.	RNPEILAA	AIRPLANE
4.	EEPSRSRU	PRESSURE
5.	ARDG	DRAG
6.	RANETSIECS	RESISTANCE
7.	HITGFL	FLIGHT
8.	LUFID	FLUID
9.	MESNCRYAIAOD	AERODYNAMICS
10.	LIREDG	GLIDER

Flight Word Scramble

Unscramble the words and write them on the line.

1. UILENLOBR ______________________________
2. FLIT ______________________________
3. RNPEILAA ______________________________
4. EEPSRSRU ______________________________
5. ARDG ______________________________
6. RANETSIECS ______________________________
7. HITGFL ______________________________
8. LUFID ______________________________
9. MESNCRYAIAOD ______________________________
10. LIREDG ______________________________

Materials list

Materials	Source	Cost
2 litre soda bottle with the neck cut off or a glass jar (tall and wide)	Walmart http://www.walmart.ca/en/ip/pepsi/6000016941356	$1.97 (1 bottle of Pepsi)
Pieces of clay or plasticine	Activity bins: 7.3 and 7.9	-
Cooking oil	Walmart http://www.walmart.ca/en/ip/great-value-vegetable-oil/6000128603955	$5.47 (1 bottle, 3L)
Stopwatch	Activity bin: 7.7	-
Thread	Walmart http://www.walmart.ca/en/ip/unique-creativ-thread-sewing-kit-24-colours/6000111967072	$1.97 (24 spools, each spool 9.1m)
8 ½" X 11" Paper	Walmart http://www.walmart.ca/en/ip/theoffice-multi-purpose-paper-500-sheets/6000016940562	$3.00 (500 sheets)
Clipboards	Amazon https://www.amazon.ca/Saunders-Recycled-Hardboard-Clipboard-5512/dp/B001JIQRLS/ref=sr_1_11?ie=UTF8&qid=1496067967&sr=8-11&keywords=clipboard	$2.51 (1 clipboard)
Tape measure	Walmart https://www.walmart.ca/en/ip/30-x-1-stanley-tape-rule-30-464cp/6000108188903	$9.98 (1 tape measure 30')
Masking tape	Activity bins: 7.1, 7.7, 8.3, 8.4, 8.6, 9.5 and 9.7	-
Scissors	Activity bins: 7.1, 7.2, 7.7, 7.8, 8.4, 8.5, 8.9 and 9.2	-
Plastic drinking straw	Activity bins: 7.6 and 7.9	-
Tape	Activity bins: 8.1, 8.6, 8.9, 9.5 and 9.8	-

Piece of Bristol board (or another type of sturdy paper)	Walmart: http://www.walmart.ca/en/ip/astroparche-cover-natural-paper/6000016937454	$12.47 (100 sheets of cardstock)