Activity Option 2: Bernoulli's Principle *(50 mins)*

Students will use facts they learn today to explore Bernoulli's principle to manipulate air pressure to see its influence on the objects around us. This is a good activity to ask colleagues to join you in facilitating.

Materials:

- Blank paper (5 sheets)
- Round balloons (10)
- Lengths of string (10 total, 18" long)
- 16oz plastic cups (10 cups)
- Ping pong balls (5)
- Student Handout
- Answer Key for Student Handout

Preparation

Try each experiment beforehand.

Step 1 (3 minutes)

Let the student know they are about to have a little FUN!

- Tell the student they will be conducting experiments to explore how air pressure influences movement and flight.

Step 2 (5 minutes)

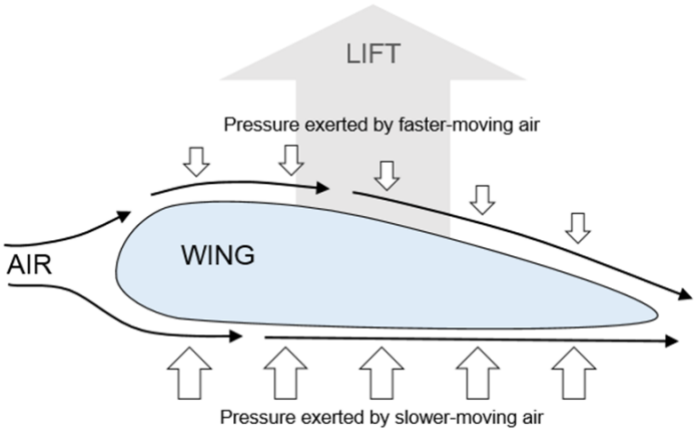
Ask them to try and define the following vocabulary and then write the correct definitions on a piece of paper.

Bernoulli's Principle - the faster air moves the less pressure it exerts. Therefore, an increase in the speed of air means a decrease in pressure. This is an inverse (or opposite) relationship.

Velocity – the speed of something in a given direction

Pressure - the continuous physical force exerted on or against an object

• The most common application of Bernoulli's Principle is in the design of a plane wing. They are curved on top and flat underneath. When in flight, the air on the bottom moves slower, which creates more pressure. Equally, the air on top moves faster which creates less pressure. This effect creates lift and allows the aircraft to fly.



Optional: draw this wing diagram out to demonstrate the principle applied to aviation.

Step 3 (5 minutes)

Ask the student to count off 1 through 5 to make groups. Pass out one ***Student Handout*** to each group. Give the student the supplies they need for each experiment:

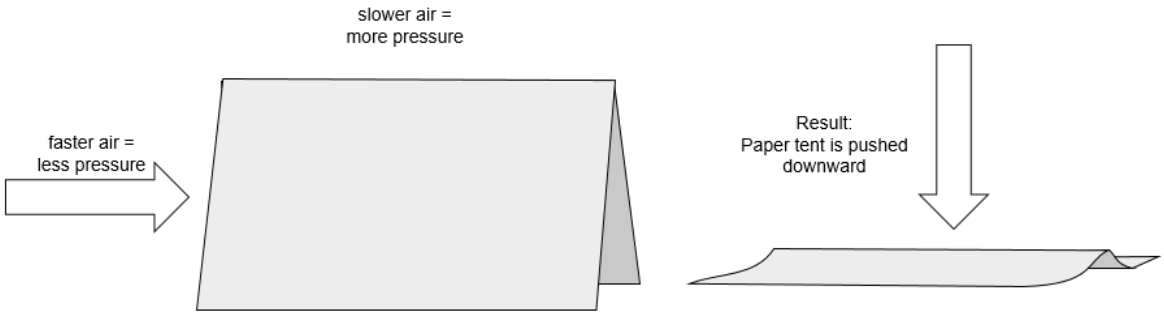
- **Experiment A:** one piece of blank paper
- **Experiment B**: two balloons, two lengths of string
- **Experiment C**: two plastic cups, one ping pong ball

Step 4 (5 minutes):

The student will use pressure to move objects, like how pressure is used to fly

Experiment A: The Paper Tent

- First, demonstrate the activity by folding a piece of paper lengthwise in half and make a paper tent (hamburger style).
- Ask the student to predict what will happen when you blow into the tent and have them complete the ***Student Handout*** Experiment A section (which is to circle their hypothesis). Help the student complete their answers.
- Have each group then fold a piece of paper lengthwise in half and make a paper tent.
- Instruct the student to blow air into the tent to test their hypothesis.
- Have the student discuss the results and if any of their hypothesis was wrong.
    - ***Result:*** *The blown air is faster than the air above the tent, so it has less pressure than the slower air above the tent and pushes the tent downward.*

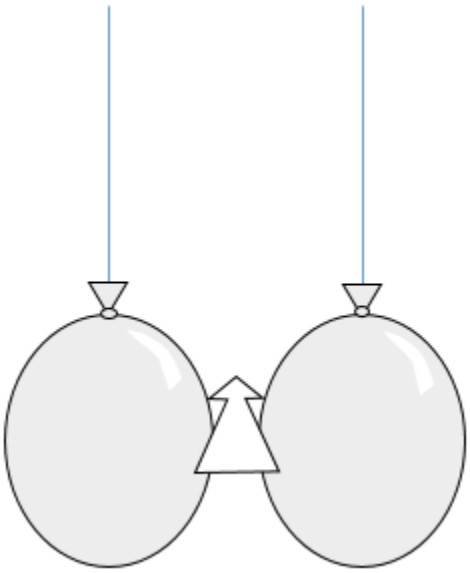


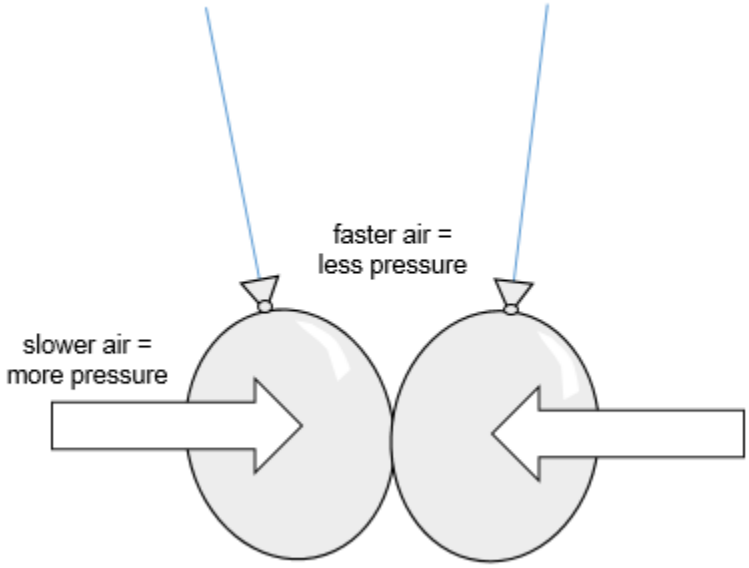
Step 5 (10 minutes):

Experiment B: Moving Balloons

- First demonstrate for the student, by blowing up your two balloons. Tie them off, and then attach a string to each one.

- Demonstrate to the student how to hold balloons 4-6 inches apart from the strings. Stress that if they hold the balloons too close together, the balloons will move away from the student. The balloons must be sufficiently apart so that the students can blow *between* the balloons, not *at* the balloons.
- From your demonstration, ask the student to ***predict*** what will happen when they blow between the two balloons and tell students to record their hypothesis under Experiment B of the ***handout***.
- Ask the student to blow up their two balloons. Tie them off, and then attached a string to each one.
- Have the student hold the balloons 4-6 inches apart. If they hold the balloons too close together, the balloons simply move away from the student. The balloons must be sufficiently far apart so that students can blow *between* the balloons, not *at* the balloons.
- Ask the student to take turns blowing air between the balloons.
- Have the student discuss the results and if any of their hypothesis were wrong.
    - ***Result:*** *The air blown between the balloons is faster than the air around it, creating less pressure than the surrounding air and forcing them together.* Have the student discuss the results.

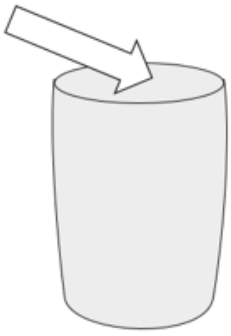




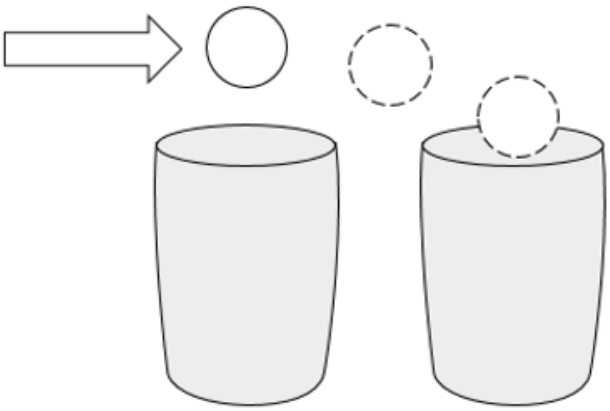
Step 6 (10 minutes):

Experiment C: Magic Moving Ball

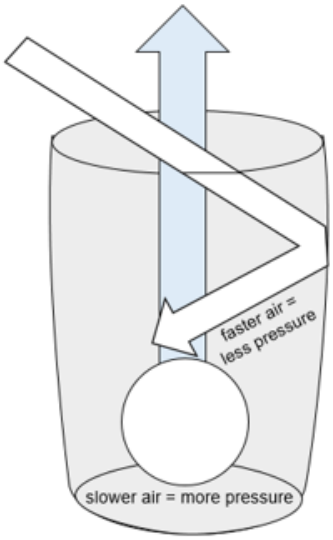
- First, demonstrate the activity by placing two plastic cups about 2 inches apart and place a ping pong ball in one of the cups.
- Ask the student to predict how they could to get the ball from one cup to the other without touching either the ball or cup. Have them to fill out their hypothesis under Experiment C of the ***Student Handout***.
- After the student have completed Experiment C section of the ***Student Handout***, have them place two plastic cups about 2 inches apart and place a ping pong ball in one of the cups.
- Have the student try a few of their ideas listed in Experiment C of the ***Student Handout***.
- Then, tell the student to gently blow across the top of the cup with the ball in it. The ball should jump from one cup to the next.
- Have the student discuss the results and if any of their ideas were wrong.
    - ***Result:*** *The air pressure moving across the top of the cup is less than the pressure inside the cup, forcing the ping pong ball to jump out of the cup.*
    - ***Extra fun:*** Have the student experiment with how far apart they can place the cups and still get the ping pong ball to jump from one to the other.



Blow air at a slight angle across the top of the cup



Once the ball raises up, blow it quickly toward the other cup



Result:
Less pressure on top of ball forces it upward

Step 7 (10 minutes)

- Go over Bernoulli's Principle again
    - The faster air moves the less pressure it exerts. Therefore, an increase in the speed of air means a decrease in pressure, producing the lift that allows airplanes to fly
- Ask the student if they can identify how each experiment exhibited Bernoulli's principle
- If they need help, you can draw the graphics from each experiment on a piece of paper and remind them that:
    - **Experiment 1:**
        - The blown air inside the tent is faster than the air above the tent, so it has less pressure than the slower air above the tent, which pushes the tent downward.
    - **Experiment 2:**
        - The air blown between the balloons is faster than the air around it, creating less pressure than the surrounding air, which forces the balloons together.
    - **Experiment 3:**
        - The air pressure moving across the top of the cup is less than the pressure inside the cup, forcing the ping pong ball to jump out of the cup.
- Thank the class for a GREAT job!
- Let them know how much you learned and enjoyed being with their class.

Student Handout

Fun with Bernoulli

Name: _____Date: _____

Experiment A: The Paper Tent

Circle the correct answer.

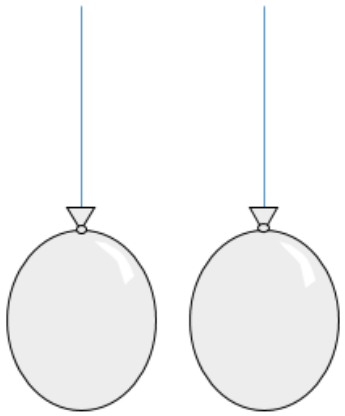
1. When I blow through the tent, the air velocity will be greater on the **(inside / outside)** of the tent.

2. I hypothesize that the tent walls will move **(in / out/ up)** when I blow through the tent.

3. Bernoulli's Principle states that as air moves faster over a surface, the pressure exerted on the surface **(increases / decreases)**.

Experiment B: Moving Balloons

Which way will the balloons move when you blow air between them? Draw arrows on the balloon diagram below to indicate which direction the balloons will move.



Experiment C: Magic Moving Ball

How will you get the ball from one cup to the other without touching either the ball or cup? Write your idea(s) below.

INSTRUCTOR ANSWER KEY FOR STUDENT HANDOUT

Fun with Bernoulli

Experiment A: The Paper Tent

Circle the correct answer.

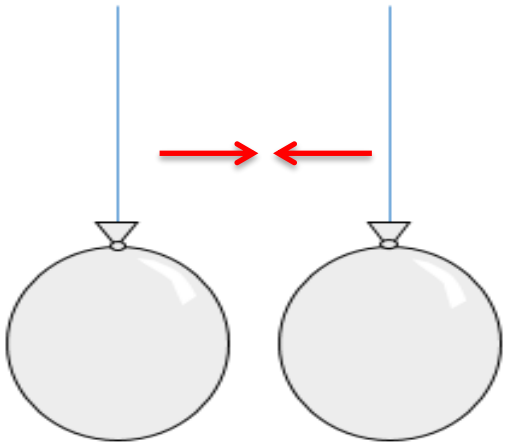
4. When I blow through the tent, the air velocity will be greater on the **(inside / outside)** of the tent.

5. I hypothesize that the tent walls will move **(in / out / up)** when I blow through the tent.

6. Bernoulli's Principle states that as air moves faster over a surface, the pressure exerted on the surface **(increases / decreases)**.

Experiment B: Moving Balloons

Which way will the balloons move when you blow air between them? Draw arrows on the balloon diagram below to indicate which direction the balloons will move.



Experiment C: Magic Moving Ball

How will you get the ball from one cup to the other without touching either the ball or cup? Write your idea(s) below.

Students will brainstorm to answer this.

Gently blow across the top of the cup with the ball in it. The ball should jump from one cup to the next.