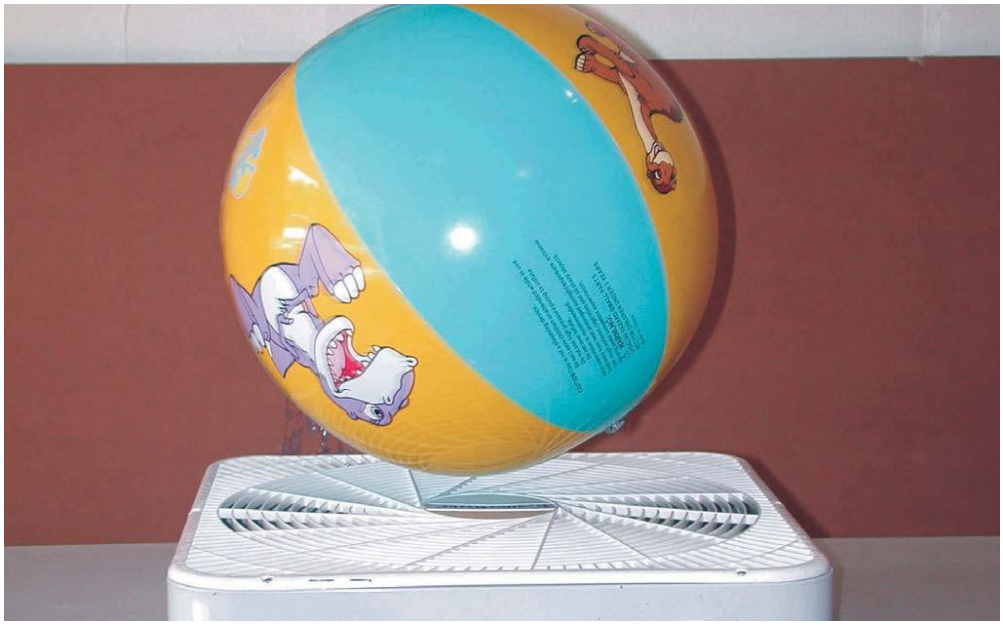
BERNOULLI BASICS
BERNOULLI BEACH BALL

OBJECTIVE – Students will learn how the air coming from a fan can be used to demonstrate Daniel Bernoulli's principle.



NATIONAL STANDARDS –
Next Generation Science Standards (https://www.nextgenscience.org/): Disciplinary Core Idea Progressions

Physical Science Progression
- ES PS2.A: Forces and Motion
- ES PS3.C: Relationship between energy and forces

Crosscutting Concepts
- Systems and system models
- Structure and function

Science and Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations (for science) and designing solutions (for engineering)

BACKGROUND - Daniel Bernoulli's Principle deals with pressure differentials. As a fluid in motion (in this case, air) accelerates, the pressure within it drops. In our example, there is a low pressure surrounding the ball because the air flow from the fan is accelerating. This is because of change of direction. As gravity tries to pull the ball to the ground (or toward the fan), a pressure differential is exerted across the surface of the ball and this keeps it in midair. The low pressure above the ball plays a major role in suspending the ball in the atmosphere.

Bernoulli Basics Demonstration #2

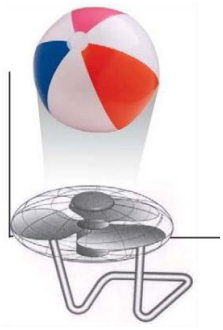
MATERIALS

a. beach ball

b. fan

PROCEDURE

To make this a meaningful learning experience, use the following explanations to the variations on the experiment:



Steps 1-5

1. First, you should have your fan in a position where the airflow will be moving upward.

2. Your fan should have some power--wimpy fans just don't work well.

3. Turn the fan on and place the beach ball in the air stream. Note how the ball remains suspended. At this point, explain to the students Bernoulli's Principle. You might try using these words: "Class, there is a flow of air moving around the ball. It is going faster because it has to change direction and this creates acceleration. As a result of this acceleration, there is a pressure drop (suction) in the stream and this is acting upon the ball."

Step 6

4. Now, gently grab the beach ball with both hands and slowly pull it toward you. As the ball is pulled from the air stream, you will feel a force trying to pull it back into the airflow. This reaction is due to the pressure differential generated between the surface of the beach ball exposed to the accelerated airflow and the relatively stationary air outside the perimeter of the fan's blast.

5. As revealed by Bernoulli, the moving air mass on one side of the ball has less pressure than the stationary air on the other side. The action produces a pressure differential. Gently release the beach ball and note how it darts back into the airflow!

Steps 7-8

6. Now, try tilting the angle of the air blast from vertical to another angle. If the flow generated by your fan is strong enough, the ball will float in midair. The low pressure above the ball plays a major role in suspending the ball. Move the fan around and note that the ball follows the airflow.

7. If your fan has enough power, place two beach balls in the air stream. Note how they battle for the center of the air stream. As they bounce off each other, observe how they move toward the center of the air blast only to bounce off each other in a repeated fashion.

8. Remember from the previous demonstration using a single beach ball, when you gently and slowly pulled the ball from the air stream, a portion of the beach ball exited the air stream and produced a pressure differential that pulled the ball back to the center of the following air mass. In this demonstration, the two beach balls are trying to occupy the same location as they see the area of low pressure!

EXTENSION

What to do: Hold a ping-pong ball over a flexible straw. As you blow into the straw, let go of the ball. What happens? Experiment with holding the straw in different ways. For example, can you tilt the straw and still keep the ball in the air? Hint: You can use any lightweight ball or a small balloon, but you may need to blow harder.

Explanation: Air is pretty pushy stuff. It never pulls or sucks, it pushes. Air is pushing on you right now from every direction. We are so used to air being around us that we often do not notice it. The constant push of air is called air pressure. As you blew through the straw, the air had to go around the ball. The air above the ball was pushing the same as before, but the air under the ball was moving faster, reducing air pressure.