Air In Motion

Students must make hypotheses about what will happen when objects comes into contact with a column of air shooting upward at high speeds. They must then apply chapter concepts to explain their observations.

◆ Expected Outcome

Astute students or those who have seen this demonstration before may realize that a Ping-Pong ball is the right size and weight to be suspended in a column of moving air. All students should make clear hypotheses about what will happen, even if the predicted result is obvious. Depending on the balls provided and the speed of the hair dryer, other balls or the balloon may be suspended in the column of air, too. Students may also discover that the flow of air can be tilted from vertical and the ball will remain suspended. After testing their hypotheses and recording the results, students should be able to explain that a ball stays in the moving column of air because the moving air is of lower pressure than the surrounding air, according to Bernoulli's principle. Students should also explain that when a ball is suspended, the pull of gravity toward Earth is balanced with the upward force of moving air. The accuracy of students' estimates about densities compared to water is less important than knowing that objects less dense than water will float and objects more dense than water will sink.

◆ Content Assessed

This Performance Assessment tests students' understanding of Bernoulli's principle, Pascal's principle, density, and buoyant force.

◆ Skills Assessed

developing hypotheses, designing experiments, applying concepts.

◆ Materials

- Provide students with variable-speed hair dryers, an inflated balloon about 15 cm in diameter, a hollow plastic or rubber ball about 3 cm in diameter, a Ping-Pong ball, and a golf ball.

◆ Advance Preparation

- Assign students to groups of two or three.
- Obtain enough balls so that each group will have one of each.
- Gather as many hair driers as possible. Students should share or take turns if necessary.

◆ Time

40 minutes

◆ Safety

Caution students not to cover the hair dryer's intake vents or exhaust opening. This could cause it to overheat. Most dryers will automatically shut off if this occurs. Students should allow the dryer to cool down before continuing. Caution students not to throw or step on golf balls.

◆ Monitoring the Task

- Check each student's hypothesis as individual hypotheses within each group may differ. Consensus is not necessary.
- Check procedural designs to see whether each student's hypothesis is tested.
- Students may discuss their observations, but each must record his or her results in his or her own words.

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In assessing students' performance, use the following rubric.

	4	3	2	1
Planning the Experiment	Plan is clear, exact, and complete, describing direction and speeds of air flow that will be used for each object. Student's hypotheses are clearly and specifically stated.	Plan is clear, exact, and nearly complete, missing only a few details of direction and speeds of air flow that will be used for each object. Student's hypotheses are broadly stated.	Plan is fairly clear but incomplete, missing some important aspects of direction and speeds of air flow that will be used for each object. Student's hypotheses are general or incomplete.	Plan is unclear or too general. Student's hypotheses do not address the experimental problem.
Performing the Experiment	Student's experiment clearly tests the hypotheses. Observations are accurate and complete.	Student's experiment tests the hypotheses. Observations are mostly accurate and complete.	Student's experiment partly tests the hypotheses. Observations are fairly accurate and complete.	Student's experiment does not test the hypotheses. Observations are inaccurate and incomplete.
Concept Understanding	Student precisely explains experimental results using Bernoulli's principle and thoroughly understands Pascal's principle and density in relation to water.	Student explains experimental results using Bernoulli's principle with minor errors but is mostly correct. Student has some minor misconceptions of Pascal's principle and density in relation to water.	Student partly explains experimental results using Bernoulli's principle but with some errors. Student has some misconceptions of Pascal's principle and density in relation to water.	Student does not use Bernoulli's principle to explain experimental results and shows serious misconceptions about Pascal's principle and density in relation to water.

Name _____ Date _____ Class _____

PERFORMANCE ASSESSMENT

Air in Motion

◆ Problem

What will happen when four different kinds of balls are put into a vertical flow of fast-moving air ?

◆ Suggested Materials

variable-speed hair dryer

balloon inflated to about 15 cm

Ping-Pong ball

hollow-centered rubber or plastic ball, 3 to 4 cm in diameter

golf ball

◆ Safety 

Review the safety guidelines in Appendix A.

Keep your hands away from the hair dryer's exhaust opening as it will get hot. Do not use the dryer near water. Do not throw or drop golf balls.

◆ Devise a Plan

1. For each of the four objects, write a hypothesis about what will happen when the object is put into the fast-moving vertical flow of air from a hair dryer.

2. Decide exactly how you will test your hypotheses. Write down your plan.

2. Carry out your plan and record your results.

◆ Analyze and Conclude

After following the plan you devised, answer the following questions on the back of this sheet or on a separate sheet of paper.

1. What happened? Were your hypotheses proven correct? Did the speed of the airflow make a difference?

2. Use your knowledge of fluids in motion to explain your observations. What forces were involved in this experiment? Were they balanced or unbalanced?

3. Does Pascal's principle apply in your experiment? Why or why not?

4. Rank the objects according to their densities. Make rough estimates of their densities compared to the density of water. Which do you think would float? Which ones would sink?