HOW DO THINGS FLY?

INTRODUCTION

This is an inquiry-based activity specifically designed for elementary level students. By working in small groups, students will understand the principles that engineers use to make a plane fly by conducting various experiments to explore the principles behind flight.

How is it that an airplane that is made of metal and carries passengers and their luggage can fly in the air weighing close to a million pounds? There are four forces that affect how a plane flies; weight, thrust, lift and drag.

- Thrust is the force, usually from the engine, that keeps the plane moving forward. When a student throws a paper airplane, their arm provides the thrust, or forward force.
- The forward motion causes the air to move around the wings, which produces lift. The wings of the airplanes are shaped a special way so that the pressure on top of the wings is less than the pressure below the wings when moving through the air, pushing upward.
- Weight is a force that is caused by gravity that pulls the plane down. Lift and weight must balance out in order for the plane to stay level in flight. If the forward motion stops, there is no more lift and the plane will fall to the ground from the force of gravity.
- Drag, also called air resistance, is the force that tries to slow a plane down. That is why most planes have a streamlined shape, so that air can glide over and under the plane easily.

LEARNING OUTCOMES

- Understand what forces act on an airplane
- Analyze how different designs of an airplane can affect its flight distance

CURRICULUM ALIGNMENT

NC ESSENTIAL STANDARDS: ELEMENTARY SCIENCE

1.P.1 Understand how forces (pushes or pulls) affect the motion of an object.

1.P.1.1 Explain the importance of a push or pull to changing the motion of an object.

1.P.1.3 Predict the effect of a given force on the motion of an object, including balanced forces.

3.P.1 Understand motion and factors that affect motion.

3.P.1.1 Infer changes in speed or direction resulting from forces acting on an object.

3.P.1.2 Compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.

3.P.1.3 Explain the effect of earth's gravity on the motion of any object on or near the earth.

5.P.1 Understand force, motion and the relationship between them.

5.P.1.1 Explain how factors such as gravity, friction, and change in mass affect the motion of objects.

5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.

5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

CLASSROOM TIME

One 90-minute block class

CRITICAL VOCABULARY

Lift: the upward force caused by lower air pressure over the wing of a plane than the pressure under the wing of a plane.

Weight: a measurement of the force of gravity pulling down

Drag: a force that slows things down

Thrust: a force that pushes things forward.

MATERIALS NEEDED

- Index cards (one for each group)
- Plastic straws (one for each group)
- Notebook paper
- Heavy duty construction paper
- Tape
- Measuring tape
- Stop watch or timer in seconds

PRE-ACTIVITIES

Teachers may want this lesson to be an introduction to the different forces that affect flight. When students have finished their self-directed inquiries within their groups and answered the questions in the worksheet, teachers can then use the information that students learned through the activities as a foundation for further teaching the concepts of flight. Teachers may want to ask students guiding questions before the activities, such as: How do

you think birds fly? Why can't an ostrich fly if it is a bird? How can planes fly even though they are made of metal and carry people and their luggage? Do you think weight hinders flight?

Teachers will need to have introduced the concept of a hypothesis and how scientists do various experiments to see if their hypothesis is correct.

ACTIVITIES

Students will work in groups to do the various activities as described in the attached worksheets:

1. Bernoulli's principle with an index card tent
2. Air resistance using different shapes of paper falling from a marked distance
3. Make airplanes out of notebook and heavy-duty construction paper and measuring the distance the planes fly.

These are inquiry-based learning activities. Students will need to hypothesize what they think will happen before they do each experiment. Follow up the activity, by having a classroom discussion on the outcomes of the various experiments. Have students explain why their hypothesis was correct or incorrect.

ASSESSMENT

Students will follow a worksheet that walks them through the various activities. Teachers can use the answers as an assessment of learning. Classroom discussions after the activities can help teachers assess how much learning took place.

MODIFICATIONS

In Activity 2 (Air Resistance), teachers can adjust the height from which to drop the notebook paper to minimize the risk to students of falling.

In Activity 3 (Paper Airplanes), teachers may mark 5 feet on the wall with tape as well as the 1-foot increments on the floor instead of the students to save time.

AUTHOR INFORMATION

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KENAN FELLOWS PROGRAM

SMT

North Carolina Science, Mathematics, and Technology Education Center

Name _____ Date_____

How do things fly?

Activity 1:

Fold an index card to make a tent hamburger style. Place it on a table. With a plastic straw, blow through one open end of the tent.

What is your hypothesis about what will happen?

_____

_____

What actually happened?

_____

_____

Why do you think this happened?

_____

_____

Activity 2:

Do you think it will take longer for a flat piece of paper to hit the floor from five feet, or a crumpled piece of paper? Why?

_____

_____

Place a piece of tape on the wall measuring 5 feet up.

- Using a stop watch or timer, measure the amount of time that it takes for a flat piece of notebook paper to hit the floor when dropped from the five feet mark.

How long did it take for the paper to hit the floor in seconds? _____

- Take the same piece of paper and crumple it into a loose ball.
- Using a stop watch or timer, measure the amount of time it takes for the crumpled paper to hit the floor when dropped from the five feet mark.

How long did it take for the crumpled paper to hit the floor in seconds? _____

- Take the same piece of crumpled paper and crumple it into a tighter ball.
- Using a stop watch or timer, measure the amount of time it takes for the crumpled paper to hit the floor when dropped from the five feet mark.

How long did it take for the tighter crumpled paper to hit the floor in seconds? _____

Activity 3:

What kind of paper airplane do you think will fly the farthest?

- Get into a group of three students.
    - Student 1 name _____
    - Student 2 name _____
    - Student 3 name _____
- Let each student make a paper airplane out of a regular piece of notebook paper.
- Go into the hallway or an open space and fly each of the airplanes.
- Using a measuring tape, measure the distance, in feet, that your airplane flew.

How many feet did your airplane fly?

Student 1 _____

Student 2 _____

Student 3 _____

Whose plane flew the farthest? _____

Why do you think that their plane flew the farthest?

_____

_____

What changes could you make to your plane to make it fly farther?

_____

_____

Now make your plane out of construction paper. Fly the airplane and measure how far it flies.

How many feet did it fly? _____

Do you think that the construction paper made a difference in how far it flew? Why?

_____

_____

How do things fly? ANSWER KEY

Activity 1:

Fold an index card to make a tent hamburger style. Place it on a table. With a plastic straw, blow through one open end of the tent.

What is your hypothesis about what will happen? Answers will vary

What actually happened? The tent should fold into itself. The moving air from the straw will cause a lower pressure inside the tent and the higher pressure outside will push the tent together.

Why do you think this happened? Answers will vary.

Activity 2:

Do you think it will take longer for a flat piece of paper to hit the floor from five feet, or a crumpled piece of paper? Why? Most students will say that the flat piece of paper will take longer, but not understand the force of air resistance on an object. Large surface areas have larger air resistance. You can explain this in terms of why a person who jumps out of a plane would need a parachute to slow them down when falling to the ground.

- Place a piece of tape on the wall measuring 5 feet up.
- Using a stop watch or timer, measure the amount of time that it takes for a flat piece of notebook paper to hit the floor when dropped from the five feet mark.

How long did it take for the paper to hit the floor in seconds? _____

- Take the same piece of paper and crumple it into a loose ball.
- Using a stop watch or timer, measure the amount of time it takes for the crumpled paper to hit the floor when dropped from the five feet mark.

How long did it take for the crumpled paper to hit the floor in seconds? _____

- Take the same piece of crumpled paper and crumple it into a tighter ball.
- Using a stop watch or timer, measure the amount of time it takes for the crumpled paper to hit the floor when dropped from the five feet mark.

How long did it take for the tighter crumpled paper to hit the floor in seconds? _____

Activity 3:

- Get into a group of three students.
  - Student 1 name _____
  - Student 2 name _____
  - Student 3 name _____
- Each student should make a paper airplane out of a regular piece of notebook paper.
- Go into the hallway or an open space and fly each of the airplanes.
- Using a measuring tape, measure the distance, in feet, that your airplane flew.

How many feet did your airplane fly?

Student 1 _____

Student 2 _____

Student 3 _____

Whose plane flew the farthest? _____

Why do you think that their plane flew the farthest?

Answers may include the fact that the plane was made with larger wing span, or more sleek in design. This is a great opportunity to talk about aerodynamics and why planes are shaped the way they are.

What changes could you make to your plane to make it fly farther? Answers may vary

Now make your plane out of construction paper. See how far it flies.

How many feet did it fly? _____

Do you think that the weight of the construction paper made a difference in how far it flew? Why?

Construction paper is actually sturdier than the notebook paper, but weighs more. If students have made planes that have a wingspan that is proportional to the length of their planes, then it should go farther with less turning. This is a good time to talk to students about why planes are made of metal. Planes used to be made of aluminum, but they have since gone to composite materials. Aluminum is a light metal, yet strong enough to stay together in flight. Composite materials have become more common because they are resistant to corrosion and rust, yet durable and light weight (in comparison to the actual plane size).