Principles of Flight

Lesson Plan: Propellers, Forces and Energy

Grade Level: 7-8

Subject Area: Science

Time Required: ***Preparation:*** 1 50-minute period
Activity: 2 50-minute periods

National Standards Correlation:

Science (grades 5-8)

- Unifying Concepts and Processes Standard: Evidence, models, and explanation.
- Unifying Concepts and Processes Standard: Change, constancy, and measurement.
- Physical Science Standard: Motions and forces.
- Science and Technology Standard: Abilities of technological designs.

Math (grades 6-8)

- Measurement Standard: Apply appropriate techniques, tools, and formulas to determine measurements.
- Data Analysis and Probability Standard: Develop and evaluate inferences and predictions that are based on data.

Summary:

Students will work in cooperative groups to build model airplanes of balsa wood, and observe the results when the number of propeller rotations is altered. The distance traveled by the model and the total duration (time) of flight will be used to calculate the average velocity and distance. Students will graph the average distance traveled versus the number of propeller rotations, interpret the data to discover relationships between the amount of potential energy (in the propeller) and the amount of work done (length of flight), and identify the types of energy and forces that relate to airplane flight.

Objectives:

Students will:

- Construct a model airplane out of balsa wood.
- Measure distances and time of flight.
- Calculate the average velocity for each trial.
- Calculate the average distance for each trial.
- Graph the average distance traveled versus the number of turns of the propeller.
- Interpret data to makes inferences about the relation between energy and work.

Background:

Airplane engines push fast moving air out behind the plane (by either propeller or jet) causing the plane to move forward. The propeller provides the thrust to move the plane horizontally. In the model, potential energy is stored in the twisted rubber band powering the propeller. When the rubber band untwists, kinetic energy is released and work is done in turning the propeller. The propeller provides the thrust, which pushes the airplane forward according to Newton's Third Law.

As the plane moves forward through the air, lift generated by the shape of the wings allows the airplane to fly. The lift force acting on an airplane is weakest at take-off and landing since the lift has a smaller value at lesser speeds. Changing the shape of the wing using ailerons and flaps increases the surface area of the wing, which adds extra lift at slow speeds.

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Materials:

Per group:

- Balsa wood model airplane with propeller (such as Delta Dart - Midwest Products Company)
- Scissors
- Glue
- Rubber band
- Pin
- Meter stick or measuring tape
- Stopwatch
- Post-it notes (2 in by 1 in)
- Flight data log
- Graph paper

Safety Instructions:

Do not fly model planes directly at another person. Use caution when flying the models. Create a single direction flight zone. Have all students stand behind the "takeoff" line. Give an "all clear" signal when it is time to fly the planes, and do not allow students to cross the "takeoff" line to retrieve airplanes that have already landed until a "retrieve all planes" signal has been given.

Procedure:

A. Warm-up

1. Review the four forces acting on an airplane – lift, gravity, thrust and drag.
2. Review Bernoulli's Principle and lift.
3. Review potential and kinetic energy.
4. Review Newton's Third Law.
5. Introduce thrust and the function of the propeller.
6. Review the jobs to be performed by each person in the group – pilot, recorder, observer, timer and measurer.

B. Activity I

Build the model airplane, following the directions given with the model.

C. Activity II

Students will run one initial test flight of their airplane to make sure that the flight path is straight, and that the plane does not bank or turn excessively to the right or left.

1. Rotate the propeller clockwise 50 turns, and hold it there.
2. Hold the plane level.
3. When the "all clear" signal is given, students will release their planes. The observers will watch to see if the plane flies straight, the timer will record the time of the flight with a stopwatch.
4. When the "retrieve all planes" signal has been given, the measurer will use the measuring tape to measure the horizontal distance from the point of release to the point of landing. The recorder will record the data.

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5. If any modifications are needed to make the planes fly in a fairly straight flight path, they should be made now with teacher input and another trial flight should be done. Only correct severe flight problems. Use post-it notes to make modifications to ailerons and elevators.

D. Activity III

1. Rotate the propeller clockwise 25 turns, and hold it there.
2. Hold the plane level.
3. When the "all clear" signal is given, students will release their planes. The observers will watch to see if the plane flies straight, the timer will record the time of the flight with a stopwatch.
4. When the "retrieve all planes" signal has been given, the measurer will use the measuring tape to measure the horizontal distance from the point of release to the point of landing. The recorder will record the data.
5. Repeat the procedure two times for a total of three trials at this propeller rotation.
6. Repeat the trial flights with the propeller rotated clockwise 50 times, 75 times, 100 times and 150 times. Record all data in the flight data log.

E. Wrap-up

1. Students will calculate the average distance traveled and the average time of flight for the three identical trials.
2. Students will calculate the average velocity by dividing the average distance by the average time.
3. Students will create a graph of the number of turns of the propeller versus the average distance traveled.
4. Students will write a lab report, including objective, observations, data, and calculations and answer questions given on the Flight Data Log.

Assessment/ Evaluation:

Students will be evaluated on their lab report, the accuracy of their data and calculations, and the accuracy of their graph.

Extensions:

1. Use EXCEL to set up the data table, calculations table and graph.
2. Calculate the kinetic energy for each trial.
3. Find the stored potential energy of the propeller from the velocity of the propeller and compare with the kinetic energy of the plane. Discuss the drag force, which prevents the two energies from being equal. 1997.

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Propellers, Forces, and Energy

Flight Log Name _____

Initial Flight Data

Number of Propeller Rotations	Description of Flight	Distance	Time	Modifications Needed
50				

Flight Trials

Number of Propeller Rotations	Distance	Time	Average Distance	Average Time

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Questions:

1. Is the relationship between the number of propeller rotations and the distance traveled linear? If not, why not?

2. What provides the kinetic energy for the plane?

3. What purpose does the propeller serve?

4. What provides the thrust for the plane?

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