EAA eActivities

Band of Whirling Dervishes

Name: _____ Date: _____

Lesson Focus

This lesson focuses on the concept of "torque," which is the **twisting motion** that affects all propeller-driven airplanes and helicopters. Students will construct a propeller and helicopter inspired device and test it to make their own definition of torque. This links to the four forces of flight (thrust, drag, lift, and gravity) with a particular focus on thrust.

Newton's third law of motion, which states that for every action (force) there is an equal and opposite reaction, is demonstrated through the movement of the helicopter responding to the rubber band rotations.

What is a whirling dervish?

Materials

1. Propeller assembly
2. Craft stick (1 cm x 10 cm) or balsa wood strip (1 cm x 17 cm)
3. Tape
4. Scissors
5. Piece of cardboard or construction paper to make helicopter
6. Markers to decorate the helicopter (optional)
7. Pencils or pens
8. Ruler
9. Rubber band
10. Paper clip
11. Card stock cut into:
    a. 5 cm x 4 cm
    b. 10 cm x 8 cm
    c. 15 cm x 12 cm
    d. 20 cm x 16 cm

Pre-Lab Questions: Please use complete sentences with correct punctuation.

1. What are Newton's three laws of motion? Write them down or look them up.

2. What is torque? Try defining and then look up a definition.

    a. What everyday items use torque?

    b. Theorize how torque might work with a helicopter's two rotors.

    c. So how does your definition apply in this instance?

    d. Can you revise your definition to be more accurate?

    e. Which of Newton's laws most applies in this case? Why?

3. Which way do you think propellers rotate on most propeller-driven airplanes? Why?

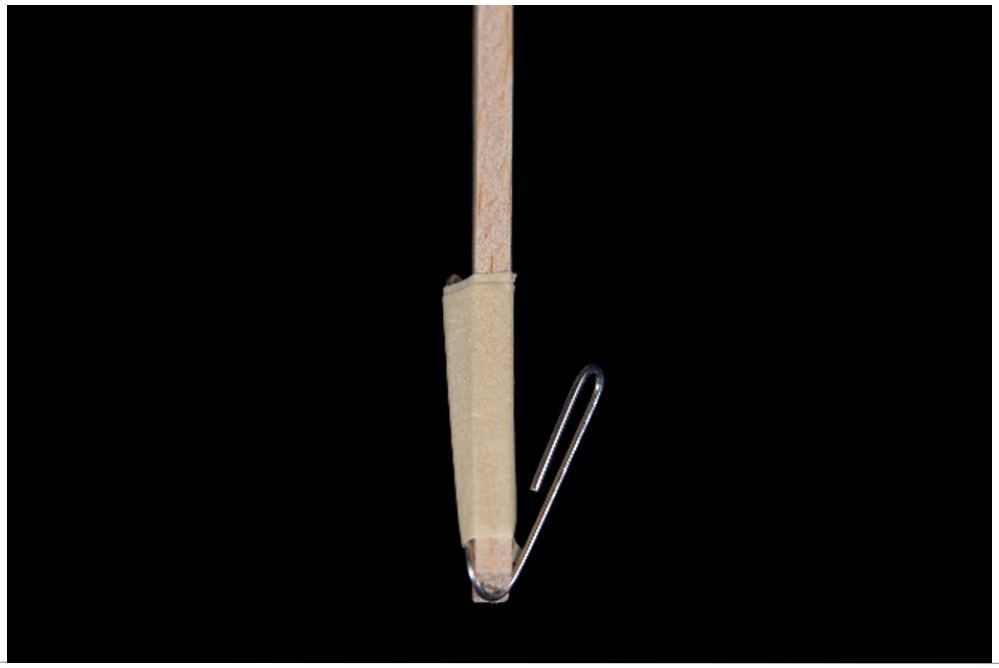
4. If the propellers rotate this way, what does this make the airplane want to do? Many British and Russian airplanes use engines that rotate in the opposite direction — what does this make the airplane want to do?

5. Airplane pilots use ailerons to counteract the rolling motion. Look up the term aileron and find an illustration where you can see one. Draw it here.

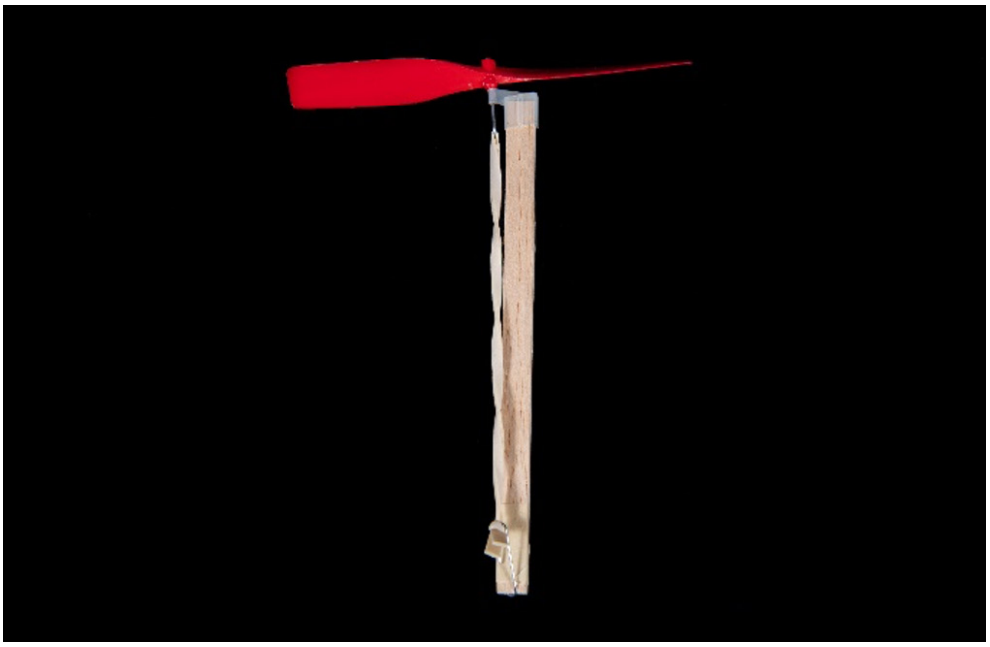
Part 1

Procedure

1. Fit the plastic cap onto the end of the craft stick to attach propeller.
2. Open the paper clip slightly and wrap around the other end of the craft stick.
3. Tape it securely.



4. Stretch a rubber band between the hook on the propeller and the paper clip.
5. Cut and retie the rubber band to provide a taut fit.



In a helicopter, the tail rotor would be used to counteract torque. Because the helicopter you are building is so light, you will be using air resistance to counteract the effects of torque. If the force of torque is left unbalanced, the rotor and the craft stick will both turn, in opposite directions (Newton's third law), and use up much of its energy. If we can counteract the torque effect, your helicopter will fly much higher!

6. Wind the propeller about 20 times, and without letting go of the helicopter, let the propeller go. Note which way the air is blowing.
7. Now wind the propeller in the other direction about 20 times and check the air direction again. For the rest of the experiment, make sure to turn the propeller in the direction that pushes the air down.
8. Without attaching a card to the helicopter, turn the propeller 35 times and let it go. Write down your observations. Repeat two more times.
9. Test each size card stock by attaching it to the craft stick, turning the propeller 35 times, and making observations. Test each size three times.

Circle the terms that show your hypothesis and fill in the blank.

Hypothesis: I think the helicopter will fly (higher or lower) when I add a (larger or smaller) piece of card stock because _____

_____.

Data

Sample Data Table: Helicopter Trials

Independent variable: the variable that is changed.

Dependent variable: the variable being measured due to the independent variable.

Trial	Card Size	Observations
1	None	
2	None	
3	None	
4	5 cm x 4 cm	
5	5 cm x 4 cm	
6	5 cm x 4 cm	
7	10 cm x 8 cm	
8	10 cm x 8 cm	
9	10 cm x 8 cm	
10	15 cm x 12 cm	
11	15 cm x 12 cm	
12	15 cm x 12 cm	
13	20 cm x 16 cm	
14	20 cm x 16 cm	
15	20 cm x 16 cm	

Was your hypothesis supported? Why or why not?

Part 2

Use the data you collected in Part 1 to re-engineer your helicopter to fly between 1.5 and 2 meters off the ground.

1. What is your dependent variable?

2. What are two possible independent variables?

Sketch your design below. Indicate the size of your card stock and how many times you will turn the propeller.

Test your design at least three times.

Trial	Card stock size	Number of turns	Height

Modify

You may choose one of your independent variables to change to see if you can get closer to the goal of 1.5 to 2 meters off the ground.

Test your design at least three times.

Trial	Card stock size	Number of turns	Height

Analysis Questions

1. What worked well with your design?

2. What other factors would you change if you could?

3. How does the helicopter use torque to provide flight? Think about what your model did.

4. What do you think the smaller back rotor on a helicopter does?

5. What would your model need to fly straight ahead?

Extension

Look at the evolution of the modern-day helicopter. Use a variety of sources, including print and digital. What uses and design changes do you think it could evolve from its present form?