ScienceNews

Teacher Background Sheet: The Physics of Flying Seeds

Use this background sheet to introduce concepts about seed dispersal via wind and basic physical science principles that explain the way winged seeds fall.

Background on the physics of maple seed dispersal
Students will benefit from a review of the physical principles behind the falling of maple seeds. Maple seeds consist of a heavy seed attached to a papery or membranous wing. The seed's center of mass is located on the boundary where the seed is attached to the wing membrane. As the seed detaches from the tree, the heavier side, where the center of mass is located, falls toward the ground at a faster rate than the less dense wing side does.

With the seed falling with the seed part down and the wing up, the variations in the wing interrupt the laminar flow of air, causing turbulence. This turbulence causes side-to-side motion of the wing, which accelerates to form a spinning vortex of air along the front leading edge of the seed. This vortex lowers the air pressure over the seed. In response to the lower air pressure, the wing lifts upward, opposing gravity and increasing air resistance. In other words, the wing acts as an air foil, which causes an angular rotation of the seed. This angular rotation generates lift along the underside of the wing, which slows the rate at which the seed falls.

The seed has both downward motion due to gravity and rotational motion due to the lift generated by the wing. This is what causes the characteristic helicopter or whirlybird motion. In windless conditions, the seed spirals down in a straight line to the ground. But in conditions in which air is moving as wind, the wind will push the seed to the side as the helicopter motion provides lift. This combination of motions carries the seed farther away from the base of the tree before the seed reaches the ground.

Background on wind dispersal of seeds
Before beginning the class discussion, brief students on the ways and reasons that plants disperse seeds. Seed dispersal is a reproductive mechanism to establish seeds in suitable growing locations away from the base of the parent plant. If seeds can disperse widely, the reproductive success of the parent plant increases.

Seeds are dispersed by floating in the wind, by drifting in water and by being carried by animals. To aid dispersal by wind, many plants have developed adaptations over many generations that make the seeds more likely to be carried long distances away from the parent plant.

Seeds dispersed by wind can take many forms, but some of the most successful seeds are gliders, parachutes, helicopters and flutterers or spinners. Gliders generally consist of a seed in the center with two wings that extend to either side, like the wings of an airplane. The seed of the Asian *Alsomitra* vine is a dramatic example of a glider. Parachute-type seeds have umbrella-like crowns of branched fibers. Dandelion and milkweed seeds are classic examples of parachutes. Helicopters, also called whirlybirds, include seeds attached at a slight angle to a one or more rigid or membranous wings that extend from one side of the seed. Maple seeds are examples of helicopters. Flutterers or spinners are like helicopters, but these seeds have seeds with a papery wing that surrounds the entire seed or extend from both sides of the seed. Whether the seed flutters or spins depends on the size, shape, and angle of the wings. Many flowering plants have fluttering or spinning seeds, including elm trees and jacarandas.

Background on the engineering design process
To learn about the engineering design process, visit the *Science News* in High Schools activity "Building better boxes based on beetles." That activity also explores concepts of biomimicry in engineering design.

Optional discussion prompts
If time permits, start the first class period with a discussion to make sure students understand core concepts about wind dispersal of seeds and are familiar with the basic physical science principles that explain the way winged seeds fall. You may want to review some physical science principles such as center of mass, air resistance, drag, lift, air foils and Bernoulli's principle. However, in-depth understanding of these principles in not required to perform the engineering activity.

Use these discussion prompts to guide students toward comprehension of the shape and proportions of maple seeds and how this shape contributes to the "helicoptering" motion of the seed as it falls. Students should be encouraged to take notes during the class discussion, so that they can refer to these concepts as they design and develop their fliers in later portions of the activity.

Have students answer the following questions during the class discussion. If time is limited, these questions could be assigned as homework or as a topic of group discussion as students build and test their models. Please note that the provided answers are examples and that student answers will vary.

1. What is wind dispersal of seeds? How does the shape of seeds affect how they are dispersed by wind?

Wind dispersal is the method of seed dispersal that relies on seeds being carried away from the parent tree by air currents or winds. Some plants' seeds have shapes or structures that allow them to be picked up and carried by the wind. These seeds can travel farther from the parent plant, so they are more likely than the seeds of other plants to land and grow in places with favorable conditions and that don't result in direct competition with the parent plant for resources.

2. What other structures help plant seeds travel long distances through the air?

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3. What questions do you still have about how the structure of seeds relates to the distance they travel when falling from the plant?

How does the size or mass of the seed affect the size of the wings? What types of motion increase the distance traveled by the seed by the greatest amount? Is there an ideal mass-to-length ratio or other proportion of mass of seed and length of wings that makes seeds travel farther? How does the number, length, width and position of wings affect the motion of the seed as it falls?

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