Science News
EDUCATOR GUIDE

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Why Baby Ducks Swim in a Line

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About this Guide

In this Guide, based on the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother," students will learn how scientists figured out why baby ducks save energy when swimming in a certain formation and discuss drag force using real-world examples.

This Guide includes:

Article-based Comprehension Q&A — Students will answer questions about the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother," which details how baby ducks save energy by surfing their mom's waves. A version of the article, "Why baby ducks swim in a line," appears in the November 20, 2021 issue of *Science News*. Related standards include NGSS-DCI: HS-PS4; HS-PS3.

> **Student Comprehension Worksheet —** These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — Students will discuss the physics of drag using real-world examples. Related standards include NGSS-DCI: HS-PS4; HS-PS3.

> **Student Discussion Worksheet —** These questions are formatted so it's easy to print them out as a worksheet.

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Article-based Comprehension, Q&A

Directions for teachers: Ask students to read the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother," which details how baby ducks save energy by surfing their mom's waves. A version of the article, "Why baby ducks swim in a line," appears in the November 6, 2021 issue of *Science News*.

1. What did scientists recently discover about swimming baby ducks?

Ducklings that swim in a straight line behind their mother can save energy by riding on waves she creates.

2. How does the finding build on previous research? Explain what was previously found.

Previous measurements of duckling metabolism showed that baby ducks saved energy when swimming behind a leader. However, the physics behind the energy savings remained an open question.

3. How did scientists make the new discovery?

Researchers used computer simulations of waves that ducks make while swimming.

4. How does the physics of ducklings swimming in a line behind a leader compare with the physics of a duckling swimming by itself?

The researchers calculated that a duckling swimming in the sweet spot behind its mother experiences a push from its mother's waves, and that each duckling in a line passes along waves that the duckling behind it can surf. A duckling swimming by itself, on the other hand, kicks up waves that resist its forward motion. Instead of a push, the lone duckling experiences wave drag.

5. What happens if ducklings fall out of line?

Swimming gets harder.

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Student Comprehension Worksheet

Directions: Read the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother," which details how baby ducks save energy by surfing their mom's waves, and answer the questions below. A version of the article, "Why baby ducks swim in a line," appears in the November 6, 2021 issue of *Science News*.

1. What did scientists recently discover about swimming baby ducks?

2. How does the finding build on previous research? Explain what was previously found.

3. How did scientists make the new discovery?

4. How does the physics of ducklings swimming in a line behind a leader compare with the physics of a duckling swimming by itself?

5. What happens if ducklings fall out of line?

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Cross-curricular Discussion, Q&A

Directions for teachers:
Ask students to read the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother" and answer the following questions with a partner. A version of the article, "Why baby ducks swim in a line," appears in the November 20, 2021 issue of *Science News*.

It would be helpful for students to have prior knowledge about drag forces or access to external resources.

Want to make it a virtual lesson? Post the online *Science News* article to your virtual classroom. Discuss the article and questions with your class on your virtual platform.

What a drag
1. Define and explain drag force.

Drag is a force that opposes the relative motion of any object through a surrounding substance. When the surrounding substance is a gas, like air, drag is referred to as aerodynamic. When the surrounding substance is a fluid, like water, drag is called hydrodynamic.

2. The formula $F_D = \frac{1}{2} \rho v^2 C_D A$ is a simple mathematical model of drag force. Define the variables and explain how each variable relates to the amount of drag on an object.

F_D is the drag force on the object, p is the density of the surrounding substance, v is the velocity of the object relative to the surrounding substance, C_D is the drag coefficient that depends on the objects size and shape, and A is the cross-sectional area of the object.

If one of any of the variables, except the relative velocity, doubled, then the resulting drag on the object would also double. If the relative velocity of the object doubled, the drag on the object would quadruple.

3. What additional factors may impact the amount of drag on a duckling swimming behind its mother?

Waves impact drag.

4. Draw a simple diagram of a single duckling swimming in a particular direction. Include a force vector to show the overall direction of drag on the duckling relative to the duckling's motion.

The drag vector should be drawn in a direction that is opposite to the direction that the duckling is swimming.

5. Draw a simple diagram of one duckling swimming behind a parent duck. Draw a force vector for the

parent duck indicating its drag direction relative to the parent duck's motion, and relative to the magnitude of drag shown in the first diagram. Finally, draw the force vector indicating the relative direction and magnitude of drag on the duckling swimming behind its parent.

All drag vectors should be drawn in a direction that is opposite to the direction that ducks are swimming. The parent duck's drag vector would probably have the largest magnitude since the parent duck's cross-sectional area is larger than that of the ducklings. The solo swimming duckling would have the second longest drag vector and the duckling swimming behind its parent would have the shortest.

Get in formation

1. What benefit do ducklings get from swimming in a line behind mom? How might this travel formation be advantageous from an evolutionary standpoint? Explain.

Swimming in the sweet spot behind another duck reduces wave drag, saving ducklings energy. That saved energy might mean that ducklings require less food resources or are better prepared to escape predators, etc.

2. In what other situations might animals benefit from traveling in a line? Make sure your answer includes specific examples.

A person swimming directly behind other people might benefit from drag reduction similar to what the ducklings experience. Water skiing, wake boarding or doing other water sports in a line may have energy saving benefits due to waves that interfere with one another.

3. What other large traveling formations on land or in the air might reduce drag for individuals within them? Choose one formation and draw a diagram to think about how the individuals are positioned relative to each other within the larger system.

Car racing, long-distance bike racing, running marathons and birds flying together are examples of large formations that might benefit individuals within them. Students should explore one of the mentioned formations with a diagram. They should think about the direction of forward movement, the magnitude and direction of potential drag and ways that the formation might reduce drag on an individual.

4. What does the formation you diagrammed have in common with the ducklings' travel formation? How might those commonalities reduce drag? What is different about the two formations, and how might those differences affect the amount of drag on individuals? (Hint: Consider the equation $F_D = \frac{1}{2} \rho v^2 C_D A$)

Student answers will vary. Students should discuss all commonalities and differences with their partners. As an example, students could compare the swimming ducklings with cyclists in a bike race. For both *formations, traveling behind other individuals is key to reducing drag. One major difference that might affect drag on ducklings and cyclists is the density of matter surrounding them.*

5. The *Science News* article explains the science behind ducklings swimming in a row behind their mother. Brainstorm another everyday thing that you see that physics could help explain.

Student answers will vary.

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Student Discussion Worksheet

Directions: Read the online *Science News* article "Here's the physics of why ducklings swim in a row behind their mother" and answer the following questions as directed by your teacher. A version of the article, "Why baby ducks swim in a line," appears in the November 20, 2021 issue of *Science News*.

What a drag

1. Define and explain drag force.

2. The formula $F_D = \frac{1}{2}\, p\, v^2\, C_D\, A$ is a simple mathematical model of drag force. Define the variables and explain how each variable relates to the amount of drag on an object.

3. What additional factors may impact the amount of drag on a duckling swimming behind its mother?

4. Draw a simple diagram of a single duckling swimming in a particular direction. Include a force vector to show the overall direction of drag on the duckling relative to the duckling's motion.

5. Draw a simple diagram of one duckling swimming behind a parent duck. Draw a force vector for the parent duck indicating its drag direction relative to the parent duck's motion, and relative to the magnitude of drag shown in the first diagram. Finally, draw the force vector indicating the relative direction and magnitude of drag on the duckling swimming behind its parent.

Get in formation

1. What benefit do ducklings get from swimming in a line behind mom? How might this travel formation be advantageous from an evolutionary standpoint? Explain.

2. What aspects of the travel formation might reduce drag in other watery situations? Make sure your answer includes examples.

3. Brainstorm examples of large formations on land or in the air that might reduce drag for individuals within them. Choose one formation and draw a diagram to think about how the individuals are positioned relative to each other within the larger system.

4. What does the formation you diagrammed have in common with the ducklings' travel formation? How might those commonalities reduce drag? What is different about the two formations, and how might those differences affect the amount of drag on individuals? (Hint: consider the equation $F_D = ½ \, p \, v^2 \, C_D \, A$)

5. The *Science News* article explains the science behind why ducklings swim in a row behind their mother.

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