COMMONLIT

Name: _____ Class: _____

# Raindrops break the speed limit

*Tiny drops fall faster than expected, and scientists don't know why*

By Stephen Ornes
2014

*In this informational text from Science News for Students, Stephen Ornes discusses scientists' surprising findings about how fast some raindrops fall. As you read, take notes on what contributes to a raindrop's top speed.*

[1] Some of those tiny raindrops that keep falling on your head may be outlaws, of a sort. They have been caught breaking the speed limit.

A falling object reaches what's known as its terminal velocity when friction — the slowing force of air — cancels the downward pull of gravity. That means the drop stops speeding up and keeps falling at a steady rate. This should be the top speed at which a droplet can move. Yet scientists have observed raindrops plummeting faster than their terminal velocity.

Michael Larsen is an atmospheric physicist at the College of Charleston in South Carolina. Bigger raindrops have a faster maximum speed than smaller ones. That's why meteorologists often use terminal velocity to estimate the size of raindrops, he says. These estimates help determine how much rain a storm deposits over an area. So the existence of fast-fallers suggests that rainfall estimates could be distorted,[1] Larsen told Science News.

"If you're going to understand rain, you need to make guesses," he says. However, he adds, "If our guesses are wrong as to how fast these drops are falling, that could ultimately affect a whole bunch of other work."



1. **Distorted** ***(adjective):*** pulled or twisted out of shape

## The puzzle

[5] A raindrop's size grows inside a cloud. A drop's one-way ride begins when it becomes heavy enough that gravity pulls it toward the ground. But air friction slows it down. Eventually, these upward and downward forces cancel out, and the drop should maintain a constant speed: its terminal velocity. (Velocity is a measurement of how fast and in which direction an object moves.) Every object falling through the atmosphere, from skydivers to hailstones, has a terminal velocity.

Raindrops larger across than 0.5 millimeter (0.02 inch) fall with a terminal velocity of several meters (feet) per second. Smaller drops fall more slowly — less than 1 meter (3.3 feet) per second. Several years ago, scientists reported seeing small drops falling faster than their predicted terminal velocity. Those researchers suspected these drops might have broken off of larger ones as they splashed against the sensor that was used to measure drop speeds.

Larsen wanted to know if such fast drops really exist. So he and his team used a rain monitor that each second took more than 55,000 pictures of falling rain. Those images helped the researchers measure the size, speed and direction of the falling drops. The researchers collected data on 23 million individual drops that fell during six major storms.

Among the smaller drops, 3 out of every 10 fell faster than their terminal velocities, Larsen's team reported online October 1 in Geophysical Research Letters.

"We don't know exactly what the cause is, but we're very confident it's not just hitting the edge of the instrument," Larsen told Science News. The small drops might have broken off larger drops in-flight. These may then have continued to fall at the faster speed, he says. If they had kept falling long enough, they might eventually have slowed down to their predicted terminal velocity.

[10] Francisco Tapiador is a climate scientist. He works at the University of Castilla-La Mancha in Toledo, Spain. The smaller drops aren't true "rain," he argues. They're just drizzle, he told Science News. So scientists may need to find a different way to calculate the terminal velocity of these mini drops, he says. Then, the data may show that the problem is not with the drops, but with how their top speed is calculated.

# Text-Dependent Questions

***Directions: For the following questions, choose the best answer or respond in complete sentences.***

1. PART A: Which statement describes the central idea of the text?
    A. Scientists have observed some smaller raindrops falling faster than what was previously calculated to be their top speed.
    B. There is no explanation for why raindrops would exceed the terminal velocities scientists predicted.
    C. Scientists are more likely to use the data collected from larger raindrops, rather than smaller raindrops, to make weather predictions.
    D. Small raindrops that are able to exceed their predicted terminal velocities likely have something poisonous or unnatural in them.

2. PART B: Which detail from the text best supports the answer to Part A?
    A. "That means the drop stops speeding up and keeps falling at a steady rate. This should be the top speed at which a droplet can move." (Paragraph 2)
    B. "Every object falling through the atmosphere, from skydivers to hailstones, has a terminal velocity." (Paragraph 5)
    C. "The small drops might have broken off larger drops in-flight. These may then have continued to fall at the faster speed, he says." (Paragraph 9)
    D. "Francisco Tapiador is a climate scientist. He works at the University of Castilla-La Mancha in Toledo, Spain. The smaller drops aren't true 'rain,' he argues." (Paragraph 10)

3. Which of the following describes the author's main purpose in the text?
    A. to show how certain aspects of the world continue to be a mystery to scientists
    B. to emphasize how quickly our scientific understanding of the natural world can change
    C. to highlight multiple causes for why smaller raindrops are exceeding their previously predicted top speeds
    D. to provide readers with scientists' studies and opinions about the abnormal speed of small raindrops

4. How do paragraphs 3-4 contribute to the development of ideas in the text?
    A. They show how difficult it is to calculate a raindrop's terminal velocity without knowing its size.
    B. They suggest that certain areas in the world are likely going to get more rain than was initially predicted.
    C. They show how the terminal velocities of small and big raindrops are calculated differently.
    D. They emphasize how important it is to have accurate calculations for raindrops' terminal velocities.

5. How are gravity and air friction related to a raindrop's terminal velocity?

# Discussion Questions

***Directions: Brainstorm your answers to the following questions in the space provided. Be prepared to share your original ideas in a class discussion.***

1. In the text, the author discusses how scientists use estimates of how fast raindrops fall to predict how much rain an area will get. What could be some consequences of false estimates and inaccurate predictions?

2. In the text, the author describes scientists carefully studying a natural phenomenon to make accurate predictions about rainfall. What else do you think scientists predict that can be useful to people and communities? How would it impact people for these predictions to be inaccurate?