ISAAC NEWTON AND THE DAY HE DISCOVERED THE RAINBOW

by Kathleen Krull

On that particular day in the early 1660s, he was not yet Isaac Newton the greatest scientist ever. He was merely an unpopular, solitary, brilliant college student. 1

That day Newton spent a rare few hours outside, at the annual market near his college. He bought a toy—a prism, a piece of glass cut according to precise angles. Though he had next to no money, the prism was so cool that he promptly bought another. 2

Shortly afterward, the plague hit England hard, and the only way to avoid catching it was to avoid other people—not a problem for a guy like Newton. In 1666, at age 24, he was forced to leave college and retreat to his remote childhood home, Woolsthorpe Manor, with his prisms and other science toys. 3

While other students might have goofed off, Newton sat still . . . and thought. Which of the many puzzles in nature could he solve while he was waiting out the plague? 4

All was quiet except for the moaning of sheep. He lived in a time and place of no distractions—no Facebook, TV, cell phone, video games, newspapers, malls. 5

The sparkling prisms caught his eye. What if he could understand the nature of color—something more accurate than what he was being taught in college? 6

Ever since the ancient Greek Aristotle said so, scholars assumed that white light was one simple thing, uniform, solid. Color, therefore, was the product of white light mixed with black. Even those in Newton's day, like Robert Hooke, continued to insist that color was a mixture of light and darkness. Hooke had invented his own personal color scale, ranging from bright red, which he claimed was pure white light mixed with the tiniest amount of darkness, to soft blue and then black, which was darkness completely blocking out the light. 7

Newton didn't see how Aristotle or Hooke could be right. 8
After all, a white page with black writing did not appear in color when viewed from a distance and the black and white blended. It appeared as gray. So he set out to prove the experts wrong—one of his very favorite activities.

The prism was the perfect tool for his experiment. Others, like 9
Hooke, were using prisms too, admiring the colors they projected when sunlight fell on them. They believed that the prism itself was somehow coloring the light. In their experiments they had placed a screen close to one side of the prism and seen the spot of light come out the other side as a mixture of color.

Newton suspected that more accurate results could be had 10
by moving the prism farther away. In his lonely study upstairs, he positioned the prism at the far wall so that it was 22 feet from the window. He let a skinny beam of sunlight pass through the prism. He observed that the beam spread out into colored bands of light, which he called a spectrum. The white light had split into different colors. How?

Newton kept thinking. His theory was that each color was a wave 11
of light and that each wave had the ability to be refracted, or bent, by something. A refracting substance, such as a prism, could bend each wavelength of light by a different angle or amount. The shorter wavelengths—those toward the violet end of the spectrum—were being bent the most. The longer wavelengths—those toward the red end of the spectrum—were being bent the least. Therefore, all the colors already existed in white light, and the prism was simply fanning them out according to their ability to be bent. Color was a matter of wavelengths radiating in a range visible to the human eye.

Newton Not Always Right

You know how everyone always tells you *not* to stare directly at the sun? Young Newton hadn't heard this important advice when he did his earliest experiments with color. He wanted to know if colors would look different when he stared at the sun. So he stared, and sure enough, the colors did change. But then specks began flickering before his eyes, and he was haunted for days. After one of these bone-headed experiments, it took two weeks before he got his normal vision back. Why he didn't go blind has always baffled people.

Trying unnecessarily to correspond to the seven notes of the musical scale (a wrong turn on his part), Newton used the seven color names red, orange, yellow, green, blue, indigo, and violet for the segments of the spectrum. 12

But the important thing he discovered was that the white light contained all the other colors. This was huge. 13

He was forgetting to eat, forgetting to sleep. So far, so good. 14

Now, to prove that the prism was not coloring the light, Newton did an "Experimentum Crucis." No, this wasn't a spell stolen from Harry Potter, but what scientists call a crucial experiment. 15

Newton placed a screen in between the window and his prism, and he cut a slit in it. He allowed only the pure green light to pass through the slit. 16

Then he grabbed his second prism and placed it in the green light. If the prism was coloring the light, the green would come out a different color. 17

But the green light remained green. The prism had no effect. 18

Newton rarely smiled, but he might have then. There was no one he could brag to yet—his rundown farmhouse was about a mile from the nearest road. But he had just established that colors were governed by scientific principles, and he suspected the rest of the natural world was, too. Oh, and he had become the first person to really understand the rainbow. 19

It was time to go think some more under his apple tree. . . . 20

Ever Since Newton

Though Newton laid the basics, scientists continue to debate color theory, often aided by artists. About 150 years after Newton, scientists began proposing a theory that three types of color receptors exist in the retina of the eye. In the 1960s, scientists proved the existence of these receptor cells, calling them cones. The three cones were sensitive to the red, blue, and green hues of the spectrum, and those hues can be blended endlessly. Today it is believed that the eye can perceive over 2.8 million different hues—more colors than even Newton could imagine.

Source: Courtesy of Kathleen Krull.