2026 History Essay Contest

School High School Winner

The Importance of X-Rays

By Helena Frieboes
Immaculata Classical Academy
Louisville, Kentucky

In hospitals today, medical devices are used continuously. They pump blood, sterilize instruments, store pressurized oxygen, and have so many other functions, without which millions of lives would be lost. One of the most common, useful, and oldest of these machines is the X-ray, which has many functions in medical environments and other situations. X-rays were discovered by Wilhelm Röntgen, a now-famous scientist whose name is recognized around the world because of his marvelous discovery.

Wilhelm Conrad Röntgen was born in Lennep, which is now on the outskirts of Remscheid, Germany on March 27, 1845. His parents were wealthy cloth merchants. In 1848, his family moved to Apeldoorn in the Netherlands. He deftly crafted mechanical devices and enjoyed nature. His family saw his talent and supported his interest in engineering. In 1862, Röntgen enrolled in the Technical School of Utrecht, but was expelled a year later on unjust grounds. Without a high school diploma, it was impossible to be accepted to any University. Röntgen instead entered the Polytechnical Institute of Zurich in Switzerland, which is now the Eidgenössische Technische Hochschule, where Albert Einstein was also educated. This school accepts students without a high school diploma. Röntgen excelled in his studies there and obtained a degree in Mechanical Engineering. It was in Zurich that he met his future wife, Anna Bertha. He obtained his doctorate one year later. August Kundt, Röntgen's teacher, inspired him to

continue experimenting with physics, so Röntgen became his assistant. After working at several different universities as a lecturer, he settled down as a professor and rector of the University of Würzburg in Germany. It was there that he made his ingenious invention of the X-ray.

Other scientists had unknowingly encountered X-rays previously but did not realize what they were observing until Röntgen published his findings. They had complained about the darkening of photographic plates while still packaged and unopened in their laboratories, but blamed it on poor manufacturing and quality. Many other scientists had played around with cathode rays, but had no idea what was causing the curious phenomena. Philipp Lenard shone cathode rays at fluorescent substances affixed to a cardboard device to find that the light intensity of the rays was proportional to material density. However, he believed that cathode rays could not travel more than a few centimeters. Röntgen was intrigued and repeated Philipp Lenard's experiments. Due to Röntgen's improved and careful technique, he found that the rays extended far beyond previous documentation. On November 8th, 1895, Röntgen covered up a Crooke's tube so as to better observe it in the dark. A Crooke's tube, or cathode ray tube, is a glass vessel in which there is a vacuum. At one side is an electrode which ejects electrons, called the cathode. At the other side is the anode, which collects the electrons. This creates a ray. Röntgen was fascinated by the viridescent glow of these rays hitting a barium platinocyanide screen. He worked tirelessly to uncover its properties, experimenting with varying materials and distances. He practically lived in his laboratory for days because he was so fixated on his experiments. Röntgen famously said, "I did not think, I experimented," which sums up his approach to scientific research. He continued to play with rays going through substances from different distances, and developed photographs with them. He referred to the rays as "X-rays" because they were unknown. It was only after much more investigation that he published his discovery, *Ueber eine neue Art von Strahlen,* in the Physikalisch-medicinischen Gesellschaft zu Würzburg (the journal of the Physical and Medical Society of Würzburg.) In it Röntgen describes, in great detail, how he conducted his investigations. Röntgen wrote that the rays generated positively or negatively charged particles in the air, with the degree of charge proportional to the intensity of the rays. We know now that X-rays are a type of ionizing radiation, which means that they are a high-energy wave. When passing through matter, they can be absorbed, transmitted or scattered according to Lambert-Beer's Law:

$$I=Ioe-ud$$

They have a wavelength from 0.01 to 10 nanometers.

Röntgen's discovery of X-rays prompted a deluge of scientific research resulting in a multitude of groundbreaking discoveries. It even created a new branch of science: radiology. The special advantage of X-rays is that they make it possible to see outside and inside of materials without the need to physically examine and possibly damage them, enabling the seeing past of substances as if they weren't there. Advanced microscopy, computed tomography, medical X-rays, and some telescopes are just a few of themany devices that use X-rays. His invention revolutionized many different fields. Archaeologists, doctors, architects, dentists, veterinarians, astronomers, art researchers, airport security, and scientists all use X-rays today. The most well-known use of X-rays is perhaps in the medical field. X-rays produce detailed images of the inner body. They show bones in detail without the necessity for surgery, allowing for quick and widely available diagnoses. Most people have, at one time or another, been exposed to X-rays in these circumstances. This is only one of the perhaps hundreds of uses for these versatile rays. X-rays are used to analyze the integrity of building structures, scan airport baggage to discover hazardous materials, show complex layers of paint in works of art, and generate images of the internal organs of long-dead mummies so that archaeologists can figure out the causes of their deaths.

While X-rays are extremely useful, they are also dangerous. Like all devices, they should be used in proper circumstances by qualified personnel. They are extremely damaging to cellular DNA, especially at high concentration and when administered frequently. They can cause cancer, malignant growths, acute radiation syndrome (ARS), atrophying of the organs, reproductive and developmental harm, and death. Many early researchers died horrible deaths because of their prolonged exposure. When X-rays were first discovered, people did not take any precautions. As a result, many were overexposed and developed cancer and diseases. It took many years for them to understand how harmful X-rays can be if not used safely. Today, precautions are taken to use a minimal amount of X-rays, guard sensitive areas with lead protective equipment, and keep radiation from leaking.

Wilhelm Röntgen's name is famous throughout the world, and in many countries X-rays are named Röntgen Strahlen after him. He received national acclaim for his discovery, including the first-ever Nobel

Prize for physics. Prizes and honors were showered upon him. However, Röntgen was incredibly humble and modest about his work. He never desired such acclaim. When thinking about the most influential invention of the modern age, innovations like the automobile, telephone, or some other crucial device might come to mind. However, sometimes the most important discoveries may be underappreciated. Most people are aware of X-rays only in the context of medical imaging and not much else. Nonetheless, they are so much more. They save lives, enable people to do things that were formerly thought to be impossible, and provide safety, precision, medical analysis, and facilitate new inventions and research. They have changed our world, and their invention triggered a domino effect of scientific breakthroughs which are still happening to this day.

X-rays have revolutionized modern technology and are indispensable today. They have changed our world forever. They are needed for their many uses, unique properties, and fast results. Making the world a better, safer place, they allow people to see inside of objects and perceive what is concealed. Of all the inventions of the modern era, X-rays are among the most important and influential.

Bibliography:

125 Years of X-Rays. Microscopy Australia. November 2, 2020. *http://micro.org.au/news/125-years-of-x-rays/*

Bellow, Sébastien and Florindo, Claudia. *What is Expansion Microscopy?* September 20. Oxford Instruments. *https://andor.oxinst.com/learning/view/article/what-is-expansion-microscopy-getting-the-most-from-expanded-samples*

Nascimento, Marcio L. F. *Brief history of X-ray tube patents.* Elsevier B. V . 2026 *https://www.sciencedirect.com/science/article/abs/pii/S0172219014000374*

Nüsslin, Fridtjof. *Wilhelm Conrad Röntgen:The scientist and his discovery.* Elsevier Ltd. November 3, 2020. *https://www.physicamedica.com/article/S1120-1797(20)30253-2/fulltext*

Ou et al. *Recent Development in X-Ray Imaging Technology: Future and Challenges.* National Library of Medicine. November 23 2021. *https://pmc.ncbi.nlm.nih.gov/articles/PMC8724686/*

Peters, P. E. *W.C. Röntgen-An European Scientist.* European Congress of Radiology. March 5-10 1995. *https://ishrad.org/wp-content/uploads/2015/11/5_WC_roentgen.pdf*

Röntgen, Wilhelm Conrad. *Ueber eine neue Art von Strahlen.* Physikalisch-medizinische Gesellschaft zu Würzburg. 1897. *https://archive.org/details/bub_gb_cPgyAQAAMAAJ/page/n17/mode/2up*

Toxicological Profile for Ionizing Radiation. Atlanta (GA): Agency for Toxic Substances and Disease Registry (US); 1999 Sep. 3, SUMMARY OF HEALTH EFFECTS OF IONIZING RADIATION. Available from: https://www.ncbi.nlm.nih.gov/books/NBK597567/

Und dann sah Röntgen den Schatten seiner Handknochen. Welt. September 2, 2023. *https://www.welt.de/wissenschaft/article243678433/Wilhelm-Conrad-Roentgen-Wie-der-Revolutionaer-fuer-Medizin-und-Technik-die-Roentgenstrahlung-entdeckte.html*

Wilhelm Conrad Röntgen. NobelPrize.org. Nobel Prize Outreach 2026. Mon. 2 Mar 2026. *<https://www.nobelprize.org/prizes/physics/1901/rontgen/biographical/*

X-rays: Non-medical X-rays. Government of Canada. January 17 2025.