

## Thanks to a woman mathematician and the military, we now have GPS

Required Annotations		Student-Created Annotations		Summary / Questions / Reflection	
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You might not be familiar with U.S. Navy mathematician Gladys West, but you've seen her work. The world would be a different place without GPS, the Global Positioning System **pioneered** by West. It has changed the world in ways that can't be measured.

West, now in her late 80s, is the African-American woman who used mathematical and computer calculations to help create the military forerunner of the widely used GPS. The system is now entwined with our everyday lives.

### Work At U.S. Naval Weapons Laboratory-Dahlgren

You might have used a smartphone for travel directions. Or you might have had lunch brought to your door by a food delivery service directed by an app. If you did, then give thanks to GPS and West. Her game-changing achievements came at the U.S. Naval Weapons Laboratory-Dahlgren, in Virginia, during her career there of more than 40 years.

GPS.gov is the official U.S. government website about GPS. It says the technology has created a wide range of opportunities for use and increased productivity. It has changed what is possible in aviation, space, public safety, disaster relief, agriculture and other governmental and commercial fields, the website says.

Last December, West received the U.S. Air Force Space and Missile Pioneers Award for her "decades of **contributions** to the Air Force's space program."

The Air Force manages the United States' GPS satellites orbiting the Earth. It is among the groups that recognize the **impact** of GPS and the major contributions of West.

### The Early Years Of GPS

The high-ranking Air Force honor recognizes the leaders of the early years of the Air Force space program. It salutes those whose vision "overcame the obstacles of the unknown." It says they "transformed the cutting edge of technology into operational systems" and dedicated their lives to exploring space for national security.

GPS technology aids America's space program and military applications, plus millions of smartphone and computer users. The technology also assists taxi services and a huge number of businesses and customers. They have benefited from West's calculations and research at Dahlgren since GPS became available to businesses in the 1980s.

Like GPS, other military innovations have revolutionized our everyday lives. They include jet engines, drones, microwave ovens and even waterproof duct tape.

The military used GPS in the mid-1990s for satellite-enhanced navigation for missile launching, communications, troop movements and other activities.

### Planetary And Satellite Work

In an interview for the 100th anniversary of the Navy's Dahlgren installation in 2018, West said that she had finished her mathematical education at the historically black college, Virginia State University, and started a teaching job before taking a position at Dahlgren. She worked there from 1956 until she retired in 1998.

At Dahlgren, West did the mathematical calculations to create the satellite-run radio navigation system operated by the U.S. Air Force. The system provides

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geolocation and time information to GPS receivers to determine locations. Geolocation is the process of finding and providing the exact location of an object such as a cellphone or Internet-connected computer.

Not long after she was hired at the military installation in 1956, West took part in groundbreaking **astronomical** studies in addition to her GPS achievements. The studies were to determine the regularity of Pluto's motion relative to Neptune, along with other planetary work.

West did calculations by hand on a mechanical calculator. They had to confirm data, she said of her work from before a computer was installed at the Naval base. "At that time, my title was mathematician, but just as I was coming to Dahlgren, they were getting a new computer in," she recalled, describing the state-of-the-art IBM Naval Ordnance Research Calculator (NORC). The NORC was arguably the most powerful computer of its day.

With the new computer, West worked on a model to use satellites. The system was to precisely measure surface elevations of the Earth and determine specific locations.

### **Detailed, Careful Work**

"That was sort of interesting. Those are the **forerunner** of the Global Positioning System," she said of her work. "When you look at the big picture, it was great, you know. But when you're working, you have got to be detailed, making sure you're accurate," she said, adding that she had the opportunity to work with "important, brilliant scientists" while at Dahlgren.

There were few black employees at Dahlgren then. West met her husband, Ira, there. The couple has three adult children and seven grandchildren.

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## **Questions**

1. Which section from the article BEST explains how Gladys West feels about what she did at the Navy's Dahlgren?
    - a) "Work At U.S. Naval Weapons Laboratory-Dahlgren"
    - b) "The Early Years Of GPS"
    - c) "Planetary And Satellite Work"
    - d) "Detailed, Careful Work"
  2. Read the following statement: "Gladys West was involved with other pioneering work that was NOT related to her GPS contributions." Which sentence from the article provides the BEST support for the above statement?
    - a) Her game-changing achievements came at the U.S. Naval Weapons Laboratory-Dahlgren, in Virginia, during her 40-plus-year career there.
    - b) At Dahlgren, West did the mathematical calculations to create the satellite-run radio navigation system operated by the U.S. Air Force.
    - c) The studies were to determine the regularity of Pluto's motion relative to Neptune, along with other planetary work.
    - d) The system was to precisely measure surface elevations of the Earth and determine specific locations.
  3. One of the central ideas is that Gladys West helped to develop a satellite system that would later become GPS. How does the author introduce this central idea?
    - a) by describing the mathematical and computer computations West used in her work
    - b) by showing that West was recently honored for her work on GPS by the U.S. Navy
    - c) by listing many of the different ways GPS is used by people throughout the world
    - d) by stating how instrumental West was in creating something that is part of our daily lives
  4. Which statement would be MOST important to include in a summary of the article?
    - a) GPS technology is used to help people with travel directions and food delivery systems.
    - b) GPS technology has had a major impact on the U.S. space program and on the country's military.
    - c) Gladys West got a mathematics degree at Virginia State University and was a teacher.
    - d) Gladys West met her husband at Dahlgren and they later had 3 children and 7 grandchildren.
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