# KATHERINE JOHNSON

Katherine Johnson (born Katherine Coleman) grew up in the USA in the early 20th century in a time of segregation and inequality. Her parents were forward-thinking and instilled their passion for equality in their children – her father used to tell her: "You are no better than anyone else, and no one is better than you", which is a belief she continues to hold in her 100th year. An outstanding mathematician, she contributed to the successful American space programme, especially connected to the Alan Shepard 1961 first American flight into space and the John Glenn 1962 first American manned orbit of Earth.

**Katherine excelled academically: she was put into a class three years ahead of what was normal for her age.**

Katherine Johnson was born on 26 August 1918 in White Sulphur Springs in Greenbrier County, West Virginia, the fourth child of Joshua Coleman and Joylette Lowe. Her versatile father was a farmer, lumberman, janitor and handyman during his working life; her mother was a school teacher. Katherine's siblings were Horace (born 1912), Margaret (born 1913) and Charles (born 1915). Katherine excelled academically – at age 5 she went straight into the second grade (equivalent to year 3 in England) of primary school and by the age of 10, she was ready for high school, which normally students enter aged 13. She showed a talent for mathematics early on, counting everything around her, from dishes, steps and stars in the night sky.

With no high school for black children in their local area, the Coleman family looked further afield. For the next few years, Joylette Coleman rented a house in Institute, Kanawha County, each September and moved there with her four children so that they could attend the high school on the campus of West Virginia State College. At the end of each school year they travelled back the 125 miles to spend the summer with their father, where he was farming. Katherine graduated from the high school aged 14, having excelled in mathematics. She also developed a love of astronomy during her school years, walking home each evening with the school principal who would point out the stars and constellations to her.

Upon leaving high school, Katherine gained a full scholarship in 1933 to West Virginia State College (now West Virginia State University). At that time, the State College was a black college, founded in 1891 as the West Virginia Colored Institute. Katherine took three subjects (English, French and mathematics) initially, deciding later to "major" (i.e. focus her studies) in both French and mathematics. One of her mathematics lecturers was William Waldron Schieffelin Claytor, an inspiring teacher who recognised her potential and ensured that Katherine took all the necessary courses to prepare her for a career in mathematics research. Realising that Katherine would need a course in analytical geometry that the College did not offer, Claytor put one on especially for her. Katherine graduated in 1937 with a Bachelor in Science in French and mathematics "summa cum laude" [with highest honour].

**At college a special course on analytic geometry was put on for her.**

**Katherine and James were married secretly in 1939 and had three daughters who became mathematicians and teachers.**

With few opportunities for black people in the USA to enter mathematics research at this time, Katherine started teaching in an elementary [primary] school in Marion, Virginia, to pass the time until a research post might become available. Katherine met her future husband, James Francis Goble, in Marion and they married secretly in 1939, since married women were not allowed in the classroom at that time. In 1940, Katherine was asked to join the post-graduate mathematics programme at West Virginia State University, which she accepted, but had to withdraw when she became pregnant with her first child. Katherine spent the next years raising her family, returning to teaching when the children were sufficiently old enough. Katherine and James had three daughters in total, Constance, Joylette and Katherine, all of whom became mathematicians and teachers.

In 1952, while visiting family in Newport News, Virginia, Katherine learnt that the National Advisory Committee for Aeronautics (NACA) in Hampton hired black female mathematicians. They had hired women as "computers" since 1935, and, because of manpower shortages due to World War II, had also hired black women in this role. The occupation of "computer" meant the person performed mathematical calculations. Katherine and James moved their family to Newport News, with Katherine working as a substitute teacher while she applied to NACA, securing a permanent position there in 1953. James secured a post as a painter in the Newport News shipyard.

**Katherine became one of the black women computers. Her work in analytical geometry meant she did invaluable top-secret work as a pioneer in the space age.**

At NACA, Katherine was assigned to the office that housed the black women computers, the West Area Computers section, supervised by Dorothy Vaughan. Initially Katherine read data from the black boxes of aeroplanes and undertook other precise mathematical tasks. She was soon loaned to the Flight Research Division, who were working on top-secret work, being pioneers of the space era. The Russians were attempting space flight and NACA was supporting the USA military strategy. Katherine's knowledge of analytical geometry and her accurate work helped the all-male flight research team accept her into their midst – and they forgot to return her to the computer section. For four years, Katherine analysed data from flight tests and worked on the investigation of a plane crash caused by wake turbulence. As this work was being completed, James died of an in operable brain tumour, in December 1956.

The Soviets launched the Sputnik satellite in 1957, which was the first artificial Earth satellite. In 1958, NACA became NASA, the National Aeronautics and Space Administration, responsible for the civilian space programme, as well as aeronautics and aerospace research. Segregation ended at this point within the organisation, with no more separate cloakrooms or canteen areas for blacks and whites. But discrimination between men and women persisted. Women were not allowed to attend briefings or put their names onto research reports. Katherine worked in the division that created the equations needed to track a space vehicle. To develop the necessary mathematics and physics to advance their work in this exciting new area, the men held briefings at which they discussed their ideas and knowledge in order to learn from each other. Katherine kept listening and asking questions about the briefing sessions, to such an extent that she wore the men down, and eventually they let her attend the briefings. Katherine provided some of the mathematics in the 1958 document "Notes on Space Technology", created from the series of lectures given by the engineers from the Flight and Pilotless Aircraft Research Divisions.

**Katherine authored, or co-authored a total of 26 research reports, the first being concerned with the theory needed to bring space vehicles back to Earth.**

Katherine also broke the restriction on women authoring research reports. Ted Skopinski and she were working on "Determination of Azimuth Angle at Burnout for Placing a Satellite over a Selected Earth Position". This report contained the theory necessary for launching, tracking and returning space vehicles to Earth. Before the report could be finished, Ted Skopinski left to go to Houston. He told the supervisor that Katherine should finish the report since she had done most of the work – with Ted's departure, the supervisor had no choice but to comply. This was the first of 26 reports that she was to co-author or author and was, arguably, the most important, since it was used for calculating trajectories, launch windows and emergency return paths for the Project Mercury spaceflights, including those for Alan Shepard in 1961 and John Glenn in 1962.

Katherine's work helped ensure that Alan Shepard's Freedom 7 Mercury capsule would be found swiftly after landing, using the accurate trajectory that had been established. When NASA used electronic computers for the first time to calculate John Glenn's orbit around Earth, there was some nervousness about the accuracy of the data. Glenn asked specifically for Katherine to verify manually the numbers that were critical to his mission, because of her reputation for accuracy. These were far more difficult calculations than needed previously for space flight, since they had to account for the gravitational pull of the celestial bodies. They required calculation of the output for eleven different variables to eight significant figures. It took Katherine a day and a half to verify the data, but her confirmations of the figures gave John Glenn the confidence that his flight should proceed.

Katherine helped calculate the trajectory for the 1969 Apollo 11 flight to the Moon, and the rendezvous paths for the Apollo lunar lander and command module. Her back-up procedures and charts helped set a safe path for Apollo 13's crew's return to Earth after the mission had to be aborted. She subsequently worked on the beginning of the Space Shuttle programme, the Earth Resources satellite and plans for a mission to Mars.

In 1959, Katherine married James A. Johnson, a former US Army lieutenant who was a Korean war veteran, and a US Army Reserve member. She served at NASA until her retirement in 1986, accruing 33 years of service. During her employment there, Katherine received the NASA Lunar Orbiter Award and won the NASA Special Achievement Award three times.

**She was mathematician of the year in 1997.**

Puzzles, bridge, travelling and watching sport are Katherine's pastimes of choice since her retirement, as well as speaking about her career to encourage students to aim high and to fulfil their potential. She was named mathematician of the year in 1997 by the National Technical Association and holds numerous Honorary degrees from various USA universities. West Virginia State College awarded her Outstanding Alumnus of the Year in 1999, and this year endowed a STEM scholarship in her honour, as well as erected a life-size statue of her on its campus. In 2015, President Barack Obama presented her with the Presidential Medal of Freedom. NASA in 2016 named one of their Langley Research Centre buildings the "Katherine G Johnson Computational Research Facility". The film "Hidden Figures", based on the lives of Katherine Johnson and two other black women computers, Dorothy Vaughan and Mary Jackson, was released in 2017.

Jenny Ramsden