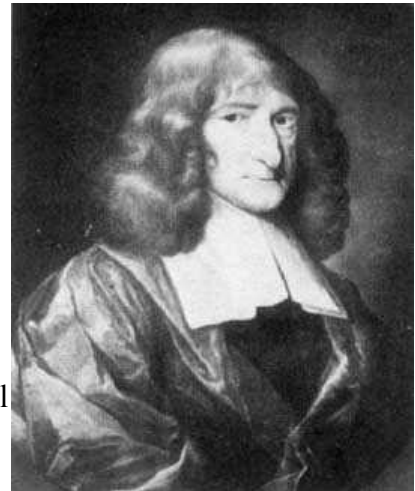


## Isaac Barrow

English mathematician and divine Isaac Barrow (October, 1630 – May 4, 1677), one of the most prominent 17<sup>th</sup> century men of science, was a pioneer in the development of differential calculus. Many of his ideas appeared later in the work of his student Isaac Newton, including the dynamic concept of curves and surfaces regarded as the paths traced by moving points and lines, respectively. Barrow moved beyond traditional boundaries in his development of kinematic geometry. He carefully



justified the use of motion in geometry, something that Aristotle would not have accepted, because he viewed mathematics as the science of immovable being. That is to say, it treats of quantitative being, and it does not, like physics, confine its attention to being endowed with motion. Barrow also departed from Aristotle through his endorsement of the methods of infinitesimals or indivisibles in relating the geometric quantities representing time and velocity.

Isaac Barrow was born in London. His father, Thomas, was a prosperous linen draper with connections at court. Thomas had plans to make his son a scholar. He sent him to Charterhouse, and paid twice the regular fee to ensure that Isaac got extra educational attention. But the lad wasted his time and gained a reputation as a bully. When his father learned of this, he transferred Isaac to Felstead, which was known for its strict discipline. Isaac was so troublesome his father was prayed that if it pleased God to take any of his children, he could best spare Isaac. At Felstead, Barrow put his considerable talents to work and when his father experienced some financial reversals so he could no longer pay his son's fees, the headmaster Martin Holbeach allowed Isaac to continue at the school because of his great potential.

It was a time of civil unrest and religious intolerance. Oliver Cromwell and the Puritans defeated the Royalists in 1649, which led to the beheading of Charles I in 1651. Barrow attended Peterhouse, Cambridge, where his uncle was a Fellow, but the latter lost his post because of his political sympathies. Barrow went to Oxford to be with his brother, who was the King's linen draper. Due to an uprising against the Royalty, Barrow left Oxford for London, and finally in 1646, Barrow accompanied an old school friend to Trinity College, Cambridge. In the midst of religious controversy, Barrow began his studies soon after loyalists replaced the majority of fellows. He supported himself by performing menial tasks but was fortunate enough to receive free tutoring from James Duport, the Regius Professor of Greek, who shared Barrow's Royalist views.

Barrow took his degree in 1648 and was elected to a fellowship in 1649. He continued at the college for a few years, earning a M.A. in 1652. He had taken an oath to study divinity when he was admitted as a fellow. The study of church history led him to astronomy, which in turn led him to geometry, which he taught himself. He wrote a simplified version of Euclid's *Elements*, printed in 1655, which remained a standard text for half a century. In 1665 Barrow ran into some difficulty over his royalist loyalties, so he left Cambridge and spent the next five years traveling on the continent, living more than a year in Constantinople, where he read and studied the works of St. John Chrysostom, whom he preferred to all other church Fathers. Barrow returned to England in 1659 and received ordination. He obtained a second bachelor's degree in divinity in 1661 and was appointed as Regius Professor of Greek at Cambridge. This was appropriate for a mathematician because at the time the Greek classics were the primary source of mathematical knowledge.

In 1663 Henry Lucas bequeathed an endowment to the University to establish the Lucasian Chair in Mathematical Studies, and the next year Barrow was selected as the first holder of the post. For reasons

not entirely clear, Barrow renounced the holy orders he had taken. He had to receive a special dispensation from the requirement that all faculty members must be ordained ministers. Henceforth Lucasian chair holders were relieved from this normal obligation. Barrow's lectures in the academic year 1664 – 1665, surely attended by Newton, were elaborately constructed and weighty expositions of reasoning, ponderous in style, dealing with the general concepts of space, time and motion. By this time Barrow had already begun to consider the study of curves as the paths of moving points. His *method of tangents* approximated the path of reasoning Newton later used in his doctrine of ultimate ratios. In the *Lectiones Geometricae* (1669) Barrow gave the first geometric description of what is nowadays called the *slope* of the *tangent* to a curve. The *Lectiones Geometricae* can rightly be viewed as the culmination of all the 17<sup>th</sup> century geometrical investigations that led to the calculus. Speaking of his interpretation of time, Barrow stated:

“...time denotes not an actual existence but a certain capacity for a continuity of existence; just as space denotes a capacity for intervening length. Time denotes motion, as far as its absolute and intrinsic nature is concerned; not any more than it implies rest; whether things move or are still, whether we sleep or wake, time pursues the even tenor of its way. Time implies motion to be measurable; without motion we do not perceive the passage of time. We evidently must regard time as passing with a steady flow, therefore, it must be compared with some handy steady motion, such as the motion of the stars and especially the sun and moon.”

Barrow resigned his position in 1669 in favor of Newton, who he acknowledged had greater gifts. This was not quite the noble gesture it might seem. Barrow decided to turn his total attention to divinity.

There was precedent for professors resigning their chairs in favor of those better suited for the position. The Regius Professor of Greek, who had assumed the chair when Barrow's former teacher was forced from it, voluntarily resigned, recognizing that Barrow was better qualified. Another thing that may have influenced Barrow to resign is that the pay for professors was pitifully small and scholars were forbidden from holding other positions within the College or the University.

From this point on Barrow did no further mathematical work. He was created Doctor in Divinity by Royal mandate in 1670, when Charles II appointed him Royal Chaplain. One day, Barrow ran into the Earl of Rochester, who earlier had referred to Barrow as "a musty old piece of divinity." With a sarcastic bow, the nobleman declared, "Doctor, I am yours to my shoe-tie." "My lord," Barrow replied, "I am yours to the ground." "Doctor, I am yours to the center." "My lord, I am yours to the antipodes." "Doctor, I am yours to the lowest pit of hell." "And there, my lord," said Barrow quickly turning to depart, "I leave you."

In 1672, calling him the best scholar in England, Charles made Barrow master of Trinity College, a post he held until his death. While there, Barrow planned the building of the Wren Library. It was Barrow's friendship with architect Christopher Wren that prompted Wren to give his services to the college gratis. The coat of arms of the most important and generous benefactors, including Barrow, were carved by Grinling Gibbons and placed on the ends of the bookcases of the new library. Sadly, Barrow did not live to see the library built. While traveling to London in 1677, he contracted a malignant fever. He tried to cure it by fasting and taking opium, a formula that had worked for him when he had been seriously ill at Constantinople. However, within a few days he died and was buried at Westminster Abbey.

Quotation of the Day: "Because Mathematicians frequently make use of Time, they ought to have a distinct idea of the meaning of that Word, otherwise they are Quacks "-Isaac Barrow