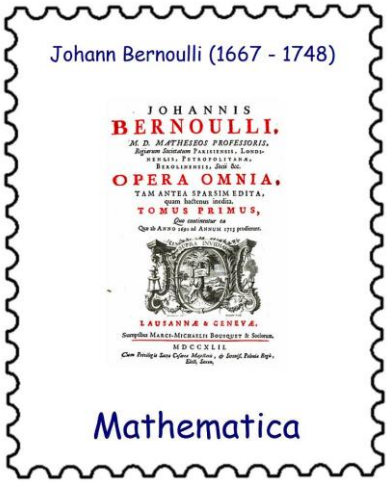
JOHANN BERNOULLI (July 27, 1667 – January 1, 1748)

by HEINZ KLAUS STRICK, Germany



JOHANN BERNOULLI was born in Basel as the tenth child of NICOLAUS and MARGARETHA BERNOULLI. JOHANN joined his father's business at the age of 15. But after a year the respected spice trader realised that his third son was not suited for the profession of a merchant. So he finally resigned himself to JOHANN studying medicine.

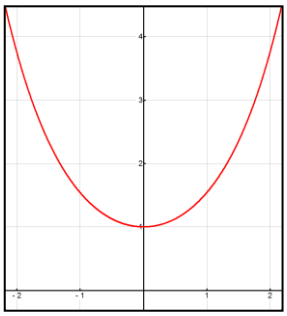
At the request of his Calvinist parents, JOHANN's twelve-year older brother JACOB had studied philosophy and theology, but he was actually more interested in mathematics and physics.

After graduating as a theologian, JACOB BERNOULLI earned his living as a private teacher in various European countries. In 1683 he returned to Basel and took over lectures in experimental physics at the university, and from 1687 the chair of mathematics.

Following his brother's example, JOHANN's interest in mathematics also grew and above all, it was the writings of GOTTFRIED WILHELM LEIBNIZ on analysis, which he quickly and increasingly familiarised himself with independently.

His special mathematical talent also became apparent to outsiders when in 1690 – at about the same time as CHRISTIAAN HUYGENS and LEIBNIZ himself – he was able to solve a problem that his brother JACOB had posed as a challenge to the mathematicians of Europe:

- *What curve do the links of an (ideal) chain take, when it is fixed at its two ends and subject only to the influence of gravity?*



This so-called *catenary* can be described with the help of the equation:

$y = \frac{a}{2} \cdot (e^{\frac{x}{a}} + e^{-\frac{x}{a}}) = a \cdot \cosh(\frac{x}{a})$.

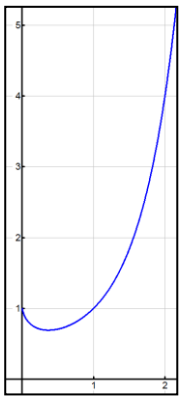
In the graph on the right, $a = 0.5$.

Despite this success, JOHANN BERNOULLI first completed his medical studies, then went to Geneva, where he lectured on differential calculus, and travelled on to Paris.

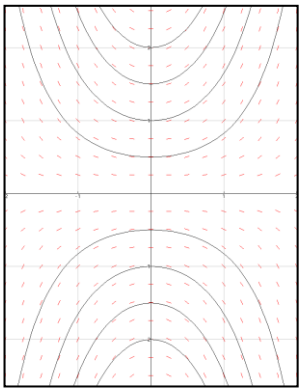
Here he agreed to give four lectures a week on infinitesimal calculus in the philosophical-mathematical discussion group of the mathematics professor NICOLAS MALEBRANCHE.

Among the participants was the wealthy nobleman GUILLAUME FRANÇOIS ANTOINE DE L'HÔPITAL, who paid him a generous fee for giving additional private lessons on calculus. JOHANN BERNOULLI continued this private instruction in written form after his return to Basel and as a fee he received half a professor's salary from L'HÔPITAL.

At the same time as he was working on his doctoral thesis in medicine, he also conducted a lively correspondence with LEIBNIZ on the applicability of the integral calculus and wrote numerous articles on the results of his investigations. The relationship with his brother JACOB deteriorated, as the latter recognised his younger brother's superior talent in some aspects and saw him as a competitor. And although JOHANN, for example, researched the phenomenon of caustics (the phenomenon of the bundling of reflected light rays) together with his brother JACOB, the two published their results in separate papers.



After completing his dissertation in medicine (1694), JOHANN BERNOULLI concentrated on the further development of his mathematical ideas, dealing, among other things, with the properties of the function with $y = x^x$ and developed a method for solving differential equations with the aid of directional fields.



At points of the coordinate system, tangents whose gradient can be calculated from the differential equation are entered in an approximate manner. In this way, you can sketch step-by-step graphs of functions that satisfy a given differential equation.

The example to the left shows graphs of functions of the type $y = a \cdot e^{\frac{1}{2}x^2}$ which satisfy the differential equation $y' = x \cdot y$.

When he even succeeded in deriving addition theorems for trigonometric and hyperbolic functions by solving differential equations, two renowned universities, Halle and Groningen, offered him a chair of mathematics in 1695.

Behind the appointment to the Dutch university was CHRISTIAAN HUYGENS, one of the leading mathematicians and physicists of the 17th century, who died, however, before JOHANN BERNOULLI and his young family took on the arduous and (since it went through war zones) perilous journey to the north of the Netherlands.

Now JOHANN had finally achieved his goal: in terms of rank he was equal to his brother JACOB.

JACOB reacted jealously to his brother's successes, who in turn did not hesitate to provoke him.

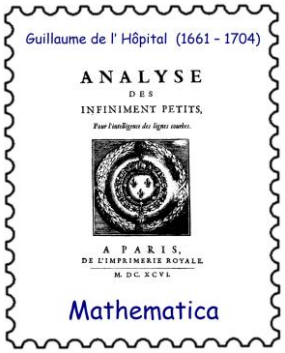
In 1696, for example, JOHANN posed the famous *brachistochrone problem* to the mathematicians of Europe, whose solution he had discovered.

- *What curve must connect two points of different heights so that a frictionless sliding mass arrives at the lower point in the shortest possible time?*

Five mathematicians submitted solutions: Isaac NEWTON, GOTTFRIED WILHELM LEIBNIZ, GUILLAUME DE L'HÔPITAL, EHRENFRIED WALTER VON TSCHIRNHAUS and JACOB BERNOULLI.

JACOB, whose solution was undoubtedly more elegant than his brother's, now challenged JOHANN with another problem:

- *What shape must a closed curve of given length have so that this curve encloses the largest possible area?*
  (the *isoperimetric* problem)



When JACOB publicly pointed out that JOHANN's solution was flawed, this was not helpful to improve the relationship between the brothers.

It was L'HÔPITAL, of all people, who was the first to publish a book on LEIBNIZ's analysis in 1696 (*Analyse des infiniment petits*).

This annoyed JOHANN greatly – especially when he realised that L'HÔPITAL has in fact published his (JOHANN's) *Lessons*.

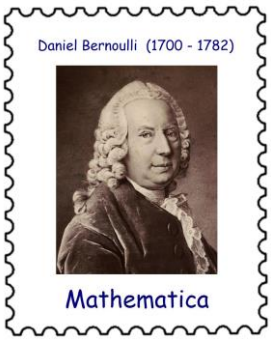
But since he was contractually bound to secrecy, he only dared to point this out after the latter's death in 1704. He was not believed, however, as he had already made several accusations of plagiarism against others.

Life in the Netherlands was not without its difficulties since JOHANN BERNOULLI was repeatedly involved in religious disputes, including being accused of not believing in bodily resurrection. When news of his father-in-law's serious illness arrived in 1705, he decided to return to Basel, where a position had been created for him as professor of Greek (which in practice would not have meant that he had to give lectures in Greek).

Arriving in Basel, he learned that his brother JACOB had died of tuberculosis a few days earlier and that his chair was now vacant.

In the following years he received offers from various universities, but he remained in Basel. His international recognition was reflected in honorary memberships of the Academies of Paris, Berlin, St Petersburg, London and Bologna.

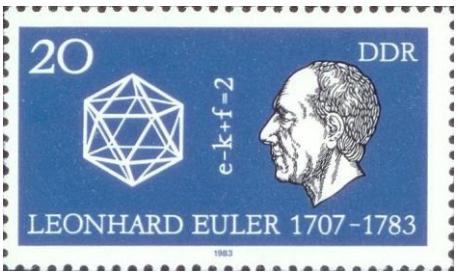
From 1713 onwards, he became heavily involved in the priority dispute between NEWTON and LEIBNIZ, who named him as a witness. After the death of the two opponents (1716 and 1727 respectively), JOHANN BERNOULLI was considered the most important mathematician in Europe ("the ARCHIMEDES of his time"). In 1742 he published his collected writings.



A dark shadow still fell on this splendour. He was outraged when in 1734, he had to share a competition prize of the *Paris Academy* with his son DANIEL.

DANIEL had returned to Basel in 1733 (after working as a mathematics lecturer in St Petersburg) and had taken over a chair of anatomy and botany there. When DANIEL published his work *Hydrodynamica* in 1738, JOHANN accused him of plagiarism and dated the publication date of his own book on the same subject back seven years to prove it.

LEONHARD EULER, whose talent JOHANN BERNOULLI recognised early on and whom he supported with all his means, seems to have been the only one whose achievements and abilities he was not jealous of.



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Translated 2021 by John O'Connor, University of St Andrews

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