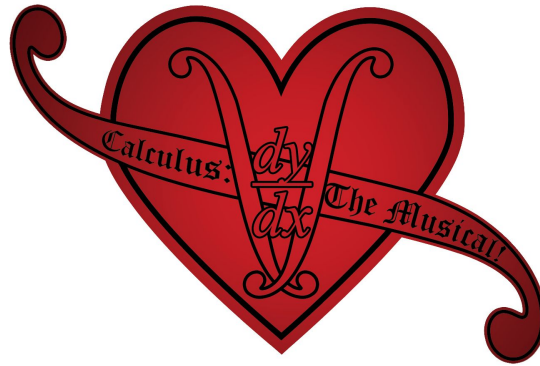


# HISTORICAL NOTES AND DISCUSSION GUIDE: CALCULUS: THE MUSICAL!

By Matheatre



## CAST OF CHARACTERS

### **ADA FRANKLIN**

A fairly typical present-day student of Calculus. She's smart, she works hard, she's generally good at math and understands most of the functions, but she has a lot of questions about WHY she's learning them and why she should put in so much effort. As the only fictional character in this play, the authors chose to name her in honor of **Ada Lovelace** (1815-1852), a mathematician whose work laid the foundations for modern computers, and **Rosalind Franklin** (1920-1958), a chemist who contributed to scientific understanding of DNA.

### **ISAAC NEWTON (1642-1727)**

Generally regarded as the father of modern physics, this genius was a mathematician, astronomer, physicist, alchemist, and all around quirky fellow. Among his most notable achievements are the mathematical definition of gravity, the eventual publication of "Principia Mathematica," and the development (or rather, the CO-development...see "Gottfried Leibniz", below), of Calculus. In a rare fit of modesty he proclaimed, in regard to his staggering vision and scope of his contribution to science, that "If I have seen further, it is by standing on the shoulders of giants." He had a reputation for being antisocial, petty and absentminded. He was obsessed with alchemy--the idea that base metals can be transformed into gold. His fascination with mercury (aka "quicksilver") was what eventually led to his death by poisoning. To the best of our modern knowledge, he did not carry around a miniature action figure version of himself, but this is the least of the poetic license the authors employ during this play.

### **ROBERT HOOKE (1635-1703)**

A contemporary and bitter rival of Isaac Newton's, this scientist (among many other things--let it be noted here that any of these characters and their lives' work could warrant entire shows of their own!) deduced the wave theory of light and was an early proponent of the use of microscopes with his ground-breaking book "Micrographia." Hooke's Law--the law of elasticity--describes the linear variation of tension with extension in a spring. Isaac Newton really did hate this guy's guts.

### **GOTTFRIED LEIBNIZ (1646-1716)**

Just another member of the Isaac Newton Fanclub Enemy List, Gottfried Leibniz is indeed the co-developer of modern Calculus. Working independently in Germany at the same time Isaac Newton was working in England, these two brainiacs came up with essentially the same discovery at pretty much the same time. However, because Leibniz was the first to publish his work and Isaac Newton was dodgy about it, Leibniz' notation is what we use to this day. Also, do you use a calculator? Thank Gottfried Leibniz.

### **ARCHIMEDES (c. 287--c. 212 BCE)**

An all-around ancient powerhouse, this mathematician, physicist, engineer, inventor and astronomer is a pretty big deal and there's no room to list all of the important contributions he made to science here. Thousands of years before Calculus was developed, he was applying concepts of infinitesimals, and developed the method of exhaustion to calculate area. If you've heard the anecdotal "EUREKA!" legend, you can pretend, like we do, that Archimedes spent a lot of time hanging out in the bathtub, thinking about cool things like math.

### **GEORG FRIEDRICH BERNHARD RIEMANN (1826-1866)**

From Hanover, Germany, he was actually way more shy and reserved than the superfly (if arrogant) rapper the authors present. He went to college to study Theology but switched majors to Mathematics instead. His work on geometry was hugely influential and paved the way for Einstein and his general theory of relativity.

### **GUILLAUME FRANÇOIS ANTOINE, MARQUIS de L'HÔPITAL (1661-1704)**

A pretty good mathematician on his own, he is best known for the rule that bears his name and the 1696 publication of "*Analyse des Infiniment Petits pour l'Intelligence des Lignes Courbes*"--the first Calculus textbook. However, it is generally accepted that most of the book's content was actually work by Johann Bernoulli, whom our dashing French hero had paid for exclusive instruction. Is it fair that he got all the credit? Does it matter when he had such an awesome wig? It should also be noted that he did not have any known interaction with Isaac Newton, but was totally penpals with Gottfried Leibniz.

## **DISCUSSION QUESTIONS**

1. The real-life Isaac Newton said he achieved his accomplishments by “standing on the shoulders of giants”—that is to say, he was building upon the achievements of his predecessors. What is the value of understanding the history of math? Why should we care about the people behind the numbers?
2. In *Calculus: the Musical!*, Ada Franklin and Isaac Newton work as peers to understand Calculus. If Ada had been a contemporary of Isaac’s, how would her opportunities in the math and science fields have differed from those available to her today? Ada also laments that her dream isn’t about “somebody awesome, like Marie Curie.” How do you think she’s commenting here about all historical figures in this play being men? Besides Marie Curie and Ada’s namesakes of Ada Lovelace and Rosalind Franklin, who are some other real-life female heroes of science?
3. This play employs a lot of anachronisms—people, things, and concepts from different points of history interacting in unlikely and sometimes humorous ways. How does our current understanding of math and science color our perspective of the past?
4. Why are you taking Calculus? How does Ada’s journey compare to your own? Did this play give you any insights about Calculus that you hadn’t considered before?
5. Newton’s derivative notation is  $y \dot{\phantom{y}}$ . The equivalent Leibniz notation for this is  $dy/dt$ . Why is Leibniz’ notation more flexible?
6. The show also uses stereotypes. Notably, Gottfried Leibniz is portrayed with some very stereotypical German props to create a cartoonish version of this historical character. When do you find stereotypes funny and when do they become offensive?

7. Despite the fact that Archimedes conceptually understood the concept of the limit and the integral, the mathematical framework which he was operating in was much more limited. How did the following changes in mathematics aid or disrupt the creation calculus as we know it:
- Cartesian coordinates
  - Roman Numerals (Used from 700 BC up until 1400 AD in Europe)
  - Arabic Numerals which had the number zero (India 500 AD, but not in Europe until about 1000 AD)
8. l'Hôpital got credit for a lot of things that really he only paid for. Can you think of any other examples, historically or contemporarily, where science was influenced by money, either positively or negatively?
9. Ada has a silly crush on l'Hôpital as a historical figure. Do you have a person from history who you just think is super cool? Not romantically (ewww!), they just inspire you in a very personal way (for the author of this list, for example, that person is Jimmy Carter).
10. The parody lyrics in *Calculus: the Musical!* were originally written to help a math teacher's students remember their formulas. How do this show's song choices and their pop cultural connotations serve to underscore the informational value of their lyrical content? Were there any songs or moments that helped you better understand Calculus or its applications?

