

Lesson 19: Galileo & Newton

Before we really start looking at **dynamics** (*the study of forces*) in depth, it would be wise to learn a little something about the two people that contributed the most to this branch of physics:

- [Galileo Galilei](#)
- [Sir Isaac Newton](#)

Galileo Galilei

Born in Pisa, Italy on February 15, 1564, died in Arcetri, Italy, January 8, 1642.

- First studied medicine in 1581 at the insistence of his parents.
- Today he is remembered mostly for his work in astronomy, mathematics, and physics.
 - He carefully constructed experiments to reduce error and ensure true observations, unlike many other "scientists" at that time.



Illustration 1: Galileo Galilei

Galileo showed that falling bodies do not have velocities proportional to their weights.

- According to [Aristotle](#), heavier objects fall faster because gravity pulls on them more.
 - Drop a book and a piece of paper at the same time and you'll see what Aristotle was talking about!
- Galileo contradicted Aristotle, saying that air resistance is to blame, not gravity.
 - To prove this he (*supposedly*) climbed to the top of the Leaning Tower of Pisa and dropped two objects, one made of metal, the other of wood.
 - According to Aristotle's theory, the heavier metal weight should have hit the ground first.
 - In fact, both hit at the same time... gravity without air resistance) acts the same on everything.
 - You can show this for the book and piece of paper you dropped by placing the paper on top of the book, and then dropping them. You got rid of the air resistance acting on the paper, so they both fall together.

In 1609, based on information from Holland, he built a telescope.

- What he saw made the Catholic Church...umm... "grumpy."
- This was because the majority of what he said either contradicted Aristotle, or in some way went against the vision of humanity at the centre of the universe.
 - Although common knowledge today, the four ideas that follow were radical in their time.

1. He found "mountains" on the [Moon](#).
"But God put it there, it should be perfect," said the Church.



Illustration 2: "Mountains" (craters) on the moon.

2. Discovered [four of Jupiter's moons](#).

“But everything is supposed to orbit us on Earth, because God put us at the centre,” said the Church.

3. He looked at the sun (not a good idea) and saw [sun spots](#), areas where the sun appears blotchy.

“But God created the sun, so it's perfect,” said the Church.

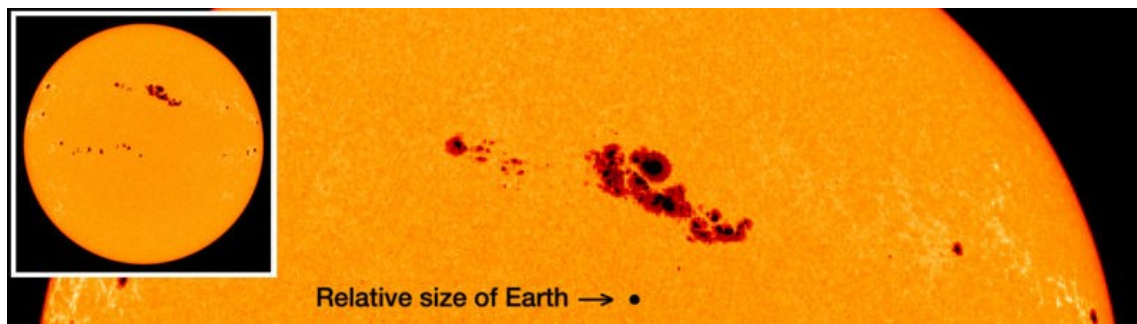


Illustration 3: A view of sun spots, with a comparison to the size of the Earth.

4. He supported the Copernican theory that the Sun is at the centre, not the Earth.

This was the excuse the Church needed to arrest Galileo.

In 1633 the Inquisition (sort of like a Catholic Church courtroom trial) forced him to abjure (*renounce*) his theories

- As punishment he was placed under house arrest for the rest of his life.
- It is claimed (but often disputed) that as Galileo stood up from his recanting, he uttered "**Eppur si muove**" which is Latin for "**And yet it moves**".
 - This is a reference to his belief that the Earth was not the centre of the universe, that it actually moves in an orbit around the sun.
- In 1979 Pope John Paul II called for Galileo's conviction to be annulled.
 - In 1992, after looking at the legal issues involved, Galileo's conviction was reversed.

For more information...

...you can read the text of Galileo's adjuration and the annulment of Pope John Paul II by visiting the **Multimedia** page on studyphysics.ca. You can also click [here](#) to read a copy of his book *Dialogue Concerning the Two Chief World Systems*.

Sir Isaac Newton

Newton was born December 25, 1642 in [Woolsthorpe](#), England, the same year that Galileo died.

- Newton's dad had died three months earlier.
- When he was three his mom remarried and moved away, leaving Newton with his grandmother.
 - This was the start of some serious mother issues, resulting in feelings of abandonment and insecurity.
- Started school at age 12 when his mom moved back (hubby had died).
 - His mom took him out of school to become a farmer, but later put him back in school when farming didn't work.



Illustration 4: Sir Isaac Newton

His uncle convinced his mom to send him to [Cambridge University's](#) Trinity College on a sort of work-study program.

- He did **not** do so great!
- Most stuff being taught was still classical “Aristotle” views.
- Newton was most interested in the modern work of Copernicus, Kepler, and Galileo.
 - He kept a second set of notes on these ideas, his “Quaestiones Quaedam Philosophicae” (Certain Philosophical Questions).

In 1665 he graduated with his bachelors degree, and was given a scholarship to pay for four more years of university.

- Cambridge closed at around this time due to the [Plague](#) sweeping the country.
- Newton moved home with his mom, and over the next 18 months he did major work in...
 - calculus
 - light and optics
 - planetary motion and gravity

Newton returned to Cambridge in 1667 and became a professor in 1669.

- He released his first major work on the subject of light and optics as part of his duties at the university.
- Robert Hooke disagreed with Newton’s work, resulting in a lifelong battle.

Newton had a nervous breakdown in 1678

- A year later his mother died, and he basically isolated himself from the world for **six years**.
 - During this time Hooke wrote an open letter to members of the Royal Society that got Newton about gravity again.
 - A visit by Edmond Halley prompted Newton to get his ideas down in writing.

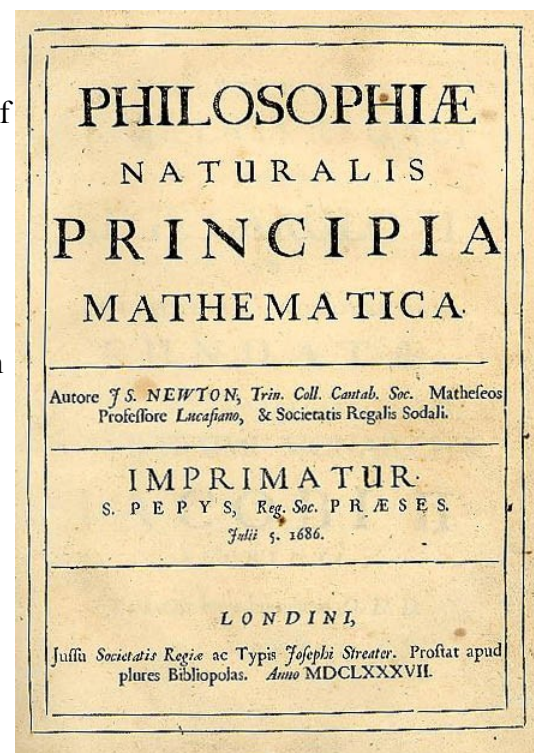
The Principia

After 18 months work Newton published the “[Philosophiae Natrualis Principia Mathematica](#)” (Mathematical Principles of Natural Philosophy) in 1687.

- Today we refer to it as simply the Principia.
- Among other things, it is in this book that he lays out his Three Laws of Motion.
- The book itself is **very** difficult to read, even back then.
 - Newton had used geometry to show everything, in order to hide the calculus he actually used. Basically, he didn't want to share his math tricks.

Robert Hooke even accused him of plagiarism.

- This was because Newton was using the idea of gravity being related to an inverse square law that Hooke had suggested in the letter several years back..
- Since Hooke never proved anything with math, Newton won.



Later Years

After publishing the Principia, Newton became less scientific and moved more towards politics.

- The first step was when he was elected MP for Cambridge in 1689.

He had another breakdown in 1693, after which he really moved even further away from science.

- This was shown in the intense interest he developed in studying the Bible and alchemy.

He became Warden of the Mint in 1696, then Master of the Mint in 1699.

- During this time he hunted down counterfeiters, prosecuting them mercilessly.
- He also moved in with his niece in London.
 - She was mistress to Lord Halifax, the guy who basically helped Newton get his job at the Mint.

In 1703 he became president of the Royal Society, a post he held till his death.

- The [Royal Society](#) is like a think tank of the best minds living in London.
 - The president actually has a great deal of power, because he can influence what gets published as well as steering research in particular directions.
- Newton acted like a dictator, suppressing ideas he didn't like.

During a visit to Cambridge, Queen Anne knighted him in 1705.

- This was not for his scientific contributions, but rather part of some political maneuvers.

In his final years we know that he had serious stomach problems.

- He was on a very strict diet and did not get around much.
- On March 30, 1727 he had horrible stomach pains and passed out. He died the next day.

In his later days Newton did seem to mellow a bit, and even acknowledge the work of others.

- In one famous quote he even pointed out that his study of physics was just a beginning and the he would never be able to discover everything

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself now and then in finding a smoother pebble or prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me."

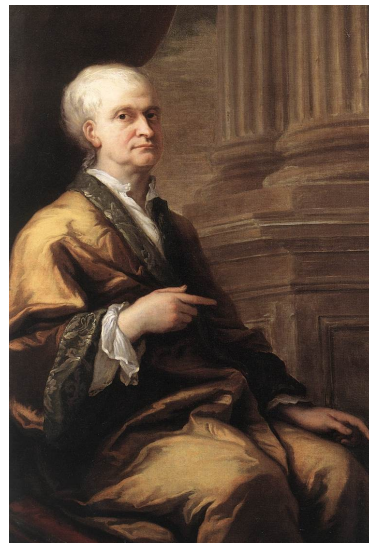


Illustration 5: Portrait of Newton by James Thornhill.