

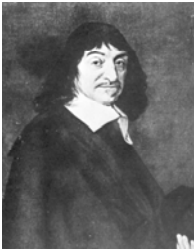
Descartes

The Man Who Would Be Aristotle

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René Descartes



- 1596-1650
- ◆ Born in Touraine, France
- ◆ Educated by Jesuits in traditional Aristotelian philosophy.
- ◆ Took a law degree, but decided that real knowledge came from experience, so he became a soldier to be around "real" people.
 - Joined the Dutch army and then later moved to the Bavarian army.
 - Apparently was a well respected officer.

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Descartes gives up on soldiers

- ◆ After some years in the army, Descartes decided that "real" people didn't know much either.
- ◆ He retired from the army to devote himself to thinking about mathematics and mechanics, which he believed would lead to true knowledge.

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Descartes a convert to Copernicus

- ◆ Wrote a book about the Copernican system (*The World*) akin to Galileo's, but suppressed its publication when Galileo was condemned by the Inquisition.

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A Dutch immigrant

- ◆ Settled in Holland where he had more intellectual freedom than in France.
- ◆ In 1649 moved to Stockholm to join the court of Queen Christina of Sweden, where, after a few months, he caught pneumonia and died.

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Undertook to build a new systematic philosophy

- ◆ In 1628 decided to create a new system of philosophy based on certainty (to replace Aristotle).
- ◆ Certainty meant mathematics.
- ◆ Descartes' goal was to replace Aristotle's common sense system with something organized like Euclid.

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Descartes' *Principles of Philosophy*

- ◆ Published in 1644
- ◆ Organized like Euclid.
 - Sought to find a starting place, a certainty, which he would take as an axiom, and build up from that.
 - All his assertions are numbered and justified, just like Euclid's propositions.

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The Principles of Philosophy

- ◆ *Part 1: Of the Principles of Human Knowledge*
 - 1. That whoever is searching after truth must, once in his life, doubt all things; insofar as this is possible.
 - 2. That doubtful things must further be held to be false.
 - ...

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Cogito, ergo sum

- ◆ *Part 1: continued*
 - 7. That it is not possible for us to doubt that, while we are doubting, we exist; and that this is the first thing which we know by philosophizing in the correct order.
 - ◆ Accordingly, this knowledge, I think, therefore I am [cogito, ergo sum] is the first and most certain to be acquired by and present itself to anyone who is philosophizing in correct order.

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Dualism asserted

◆ Part 1: continued

- 8. That from this we understand the distinction between the soul and the body, or between a thinking thing and a corporeal one.
 - ◆ Note that this follows immediately after his "cogito, ergo sum" assertion.

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The two worlds

- ◆ Descartes assertion divides the world into two totally separate compartments:
 - *Res cogitans* – the world of the mind.
 - *Res extensa* – the world of things that take up space.

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Res cogitans

- ◆ The world of the mind.
- ◆ Descartes wrote extensively about this, what is now considered his psychological and/or philosophical theory.
 - The main point for science is that it does not directly affect the physical world.

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Res extensa

- ◆ The world of extension, i.e., the physical world, was, for Descartes, totally mindless.
 - Therefore *purpose* had no place in it.
- ◆ *Res extensa* obeyed strictly mechanical laws.
 - Compare Aristotle's natural motion.

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Motion in Res Extensa

- ◆ *Part II: Of the Principles of Material Objects*
 - 36. That God is the primary cause of motion; and that He always maintains an equal quantity of it in the universe.
 - ◆ This is the *principle of conservation of motion* – there is a fixed quantity of motion in the universe that is just transferred from one thing to another.

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Inertial motion

- ◆ *Part II: continued*
 - 37. The first law of nature: that each thing, as far as is in its power, always remains in the same state; and that consequently, when it is once moved, it always continues to move.
 - ◆ This is the *principle of inertia*, which, along with conservation of motion, asserts that motion is a natural thing requiring no further explanation.
 - ◆ Compare this to Aristotle, for whom all motion required an explanation.

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Projectile motion

◆ Part II: continued

- 38. Why bodies which have been thrown continue to move after they leave the hand...having once begun to move, they continue to do so until they are slowed down by encounter with other bodies.

- ◆ Descartes here disposes of Aristotle's *antiperistasis* problem. A projectile keeps moving because it is natural that it do so.

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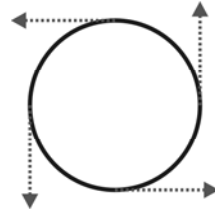
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Straight line motion

◆ Part II: continued

- 39. The second law of nature: that all movement is, of itself, along straight lines; and consequently, bodies which are moving in a circle always tend to move away from the centre of the circle which they are describing.

- ◆ Anything actually moving in a circle is always tending to go off on a tangent. Therefore the circular motion requires a cause.



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Relentless Mechanism

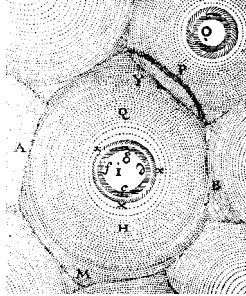
- ◆ Inertial motion was natural.
- ◆ Pushes and pulls transferred motion from one body to another.
- ◆ Everything in *Res extensa* worked like a machine (e.g. windmill, waterwheel, clock).
- ◆ Forces were occult – i.e. came from another world, therefore forbidden as an explanation.

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Vortex Theory

- ◆ Where (Aristotelian) Logic leads.
- ◆ If natural motion was in straight lines, why did the planets circle the Sun?

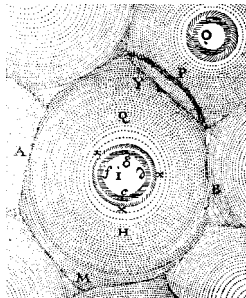


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Vortex Theory, 2

- ◆ Answer: They are pushed back toward the centre by all the invisible bits that fill the universe.
 - The universe is spherical and full.
- ◆ Think of water in a bucket.



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Living bodies are machines

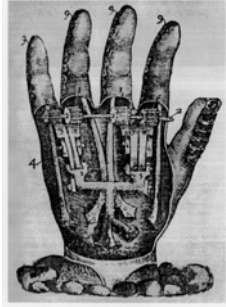
- ◆ The soul belongs to Res cogitans.
- ◆ Anything in the physical world must be mechanical.
- ◆ All living things are merely complex machines.
 - Animals were mere machines, no matter how much emotion they appeared to show.

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The Human Body as a Machine

- ◆ Living bodies were merely very complicated systems of levers and pulleys with mechanisms like gears and springs.



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Automata

- ◆ French clockmakers produced toy automata that made the mechanical body conceivable.
 - The monk kicks his feet, beats his chest with one hand, waves with the other, turns his head, rolls his eyes, opens and shuts his mouth.



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The Human Condition

- ◆ Since human being had souls and also had volition, there must be some communication for them between Res cogitans and Res extensa.
- ◆ But how is this possible if the worlds are totally separate?

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The Pineal Gland

- ◆ In Descartes' time, anatomists had discovered a tiny gland in the human brain for which they knew no purpose.
 - It was not known to exist in the brains of other animals. (It does.)
 - This was the *Pineal Gland* (it was shaped like a pine cone).
- ◆ Aha!, thought Descartes. This is the seat of communication for the soul and the body.

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The Pineal Gland in action

- ◆ Descartes' idea was that the pineal gland received neural transmissions from the body, communicated them to the soul, which sent back instructions to the body.



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God the clockmaker

- ◆ Descartes, the Jesuit-trained philosopher and lifelong Catholic, saw God's role as being the creator of the universe and all its mechanisms.
 - God, the Engineer.
 - This became a popular theological position for scientists.

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The Analysis of Res Extensa

- ◆ Among Descartes' most useful contributions to science were the tools he developed for studying the physical world.
- ◆ Most important among these is the development of a new branch of mathematics: Analytic Geometry.

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Analytic Geometry

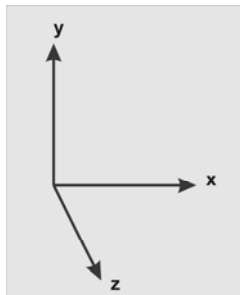
- ◆ A combination of geometry, taken from Euclid, and algebra, taken from Arab scholars, and traceable back to ancient Egypt.
 - Geometry was generally used to solve problems involving lines and shapes.
 - Algebra was most useful for finding numerical answers to particular problems.
- ◆ Descartes found a useful way for them to work together.

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Cartesian Coordinates

- ◆ The extended world can be divided into indefinitely smaller pieces.
- ◆ Any place in this world can be identified by measuring its distance from a fixed (arbitrary) beginning point (the origin) along three mutually perpendicular axes, x , y , and z .



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Analytic Geometry

◆ Geometric figures and paths of moving bodies can be described compactly with Cartesian coordinates.

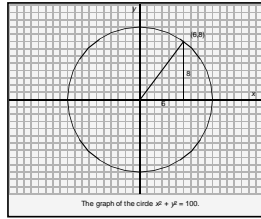
◆ A circle:

$$x^2 + y^2 = 10^2 = 100$$

◆ This is a circle of radius = 10.

◆ Every point on the circle is a distance of 10 from the centre.

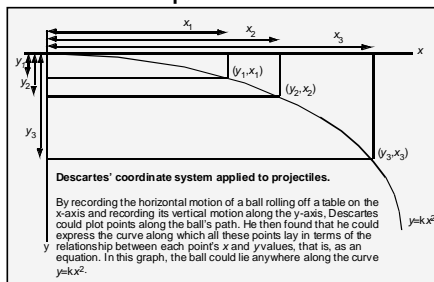
◆ By the Pythagorean theorem, every point (x, y) on the circle makes a right triangle with the x and y axes.



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Capturing Projectile Motion in an equation



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