

Science and Society

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Spring/Summer, 2010

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My TOALC page
<http://froglevel.org/toalc>

Wikipedia
<http://en.wikipedia.org>

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Questions are welcome anytime. The instructor will limit discussion only for time constraints and to stay on topic

Extra credit for catching the instructor in a mistake!

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Introduction: What is Science and how do we develop scientific facts?

Evolution

Global Warming

Genetics: An Update

Particle Physics, the LHC, and Cosmology (2 weeks)

Alternative Energy: An Update

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What is Science?

The meaning of science, how it is done, and what it achieves is widely misunderstood in spite of its dominant role in our daily lives.

What is science and what is “the scientific method”?

How did we come to understand why objects such as billiard balls move the way they do?

How did we come to understand the evolution of living organisms?

What are the differences distinguishing science, engineering, and technology?

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What is Science?

Your science textbooks notwithstanding, there is no such thing as “the scientific method”

Is science the application of Mathematics?

“Witch doctors have a method and astrologers use mathematics,” Paul Feyerabend

Much in science is discovered “by accident”

Science is a set of values and goals

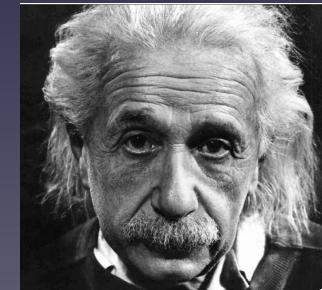
A very simplified definition is “understanding the world using observations and logical explanations of those observations”

Observations

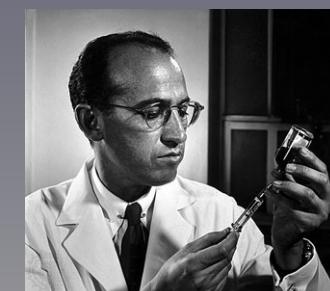
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What is Science?

Science progresses by the isolated moments of genius of strange, unsocial, obsessive, loner geeks



Science progresses through persistent, consistent hard work and from demands for experimental evidence and rigid logic



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What is Science?

What is Science notes by Bruce Railsback,
Professor, Department of Geology, University of
Georgia

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Where to start???

Science assumes that the universe exists outside our minds

Science assumes that the universe is stable, continuous, and observable

Science assumes we are not the victims of a cosmic hoax

Science is limited to explain what we can observe

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What is Science?

Observations make the building blocks of science

- We see the sun go overhead each day
- We see the sun go overhead differently by the seasons

Explanations are called theories

- The sun revolves around the earth
- The earth and other planets spin and revolve around the sun
- Explanations that account for only some observations are incomplete or wrong

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What is Science?

Observations

Repeatable, objective observations → facts

Explanations

Logical, consistent, complete explanations → theories

Opinions

Desires

~~Other explanatory systems: philosophy, religion~~

Theories can become fact for all practical purposes

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Proving Scientific Facts

In mathematics a proof is very formal and exactly logical

Prove that the sum of two even integers is even

- Consider two even integers x and y .
- Since they are even, they can be written as $x=2a$ and $y=2b$ respectively for integers a and b .
- Then the sum $x + y = 2a + 2b = 2(a + b)$.
- From this it is clear that $x+y$ has 2 as a factor and therefore is even, therefore the sum of any two even integers is even.

This proof uses prior definitions and proofs; e.g., the distributive property of multiplication

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Proving Scientific Facts

Scientific proofs aim for the elegance and clarity of mathematical proof, but they must use indirect evidence and rely on prior knowledge of many kinds

Some phenomena cannot be detected by our natural senses

Some phenomena occur in time and space where we cannot go directly

Scientific proof is sometimes like legal proof

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Proving Scientific Facts

A wealthy woman has been murdered in her bedroom. Who did it?

- We can find no evidence of breaking and entering
- Security cameras in the house show the butler removing a pistol from a cabinet in the pantry
- The time stamp on the tape indicates he took the pistol about the time that the coroner says the woman died.
- Another tape shows the butler walking down the hall and up the stairs to the bedroom with a towel covering his right hand
- There is no camera in the bedroom, but we hear her scream, “Why, Jeeves? I've employed and trusted you for so long!”
- Voluminous additional evidence indicates that Jeeves Jones, the butler, did it

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Proving Scientific Facts

No other suspect fits the evidence, but...

The butler denies that he murdered her, and

The butler's wife denies that he killed his employer.

The butler's lawyer points out that:

- We did not see the butler pull the trigger
- We did not see the woman fall to the floor while the butler was in the room

The butler is convicted of first-degree murder

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Scientific Fact and Controversy

Evolution: Conflict with traditional views

Global Warming: Conflict with economic issues and traditional attitudes about nature

Particle Physics and String Theory: Human nature and politics invade science