

# Introduction: What is science? What is philosophy of science?

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<http://philosophy.ucsd.edu/faculty/wuthrich/>

**145 Philosophy of Science**  
Class 1, 1 April 2008

# Course website

`http://philosophy.ucsd.edu/  
faculty/wuthrich/teaching.html`

There, you can find:

- syllabus (make sure you get an up-to-date copy)
- lecture slides
- links to readings
- handouts
- **midterm exam**
- ...

**You are responsible for reading your email.**

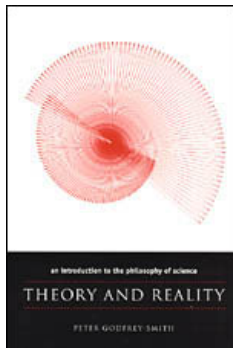
## Contact me

Office hours: Tu 3-5pm, and by appointment

Room 8047 HSS

☎ 858-534-6548    ✉ [wuthrich@ucsd.edu](mailto:wuthrich@ucsd.edu)

## Required text



Peter Godfrey-Smith, *Theory and Reality: An Introduction to the Philosophy of Science*, The University of Chicago Press, 2003. (\$27)

This book is available at the Groundworks bookstore in the Student Center.

# Course requirements and evaluation

“The grade for this course will be determined by the total points a student earns from the three types of evaluation indicated below. I guarantee that a total of 60 points will earn at least a **D** and a total of 70 points will at least get you a **C**. If you take the class for a Pass/Fail grade, you must have at least a **C** in order to pass the class.”

# Three types of evaluation

- 1 Quizzes (20 points)
- 2 Midterm papers (2×20 points)
- 3 Final exam (40 points)

Both midterm papers must be submitted **both as hard copies as well as through `turnitin.com` by their due dates** in order to earn credit.

turnitin.com

Enroll in this class at `turnitin.com` by creating a new profile.  
You will need the following information:

Class ID = 2189041

Enrollment Password = phil145sp08

Please come and see me if you have trouble creating or  
accessing an account. Troubles like these will not be an  
acceptable reason for late assignments.

## (1) Quizzes (20 points)

“There will be **five short quizzes** during the quarter, each worth 4 points. They will be announced in class one meeting before they will be held. No make-up quizzes will be given.”

## (2) Midterm paper (2×20 points) [turnitin.com]

“There will be two **take-home midterm papers** due on 29 April and 20 May 2008 at the beginning of class. These papers are “open books”, i.e. you are allowed—and encouraged—to use any sources such as libraries or the internet, and you are permitted to discuss the papers with your classmates. All sources, including discussions with classmates, must be appropriately acknowledged. *All answers given must be in your own wording.* Closely paraphrasing or simply copying the work of others (such as authors of books or articles, or classmates) is not allowed and will be severely penalized. You must ask me in case you are uncertain whether something constitutes plagiarism. For each day your paper is late, five points will be deducted from your point total, although no negative point totals will be given for the midterm papers.”

## (3) Final exam (40 points)

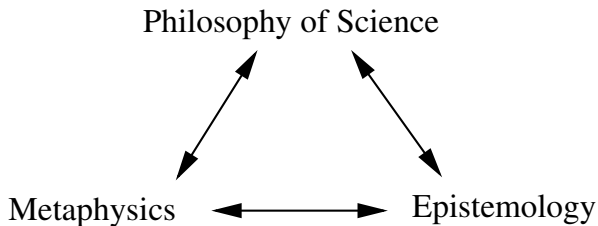
“There will be a **final exam** on TBA, in a location to be announced. This exam will consist only of multiple-choice questions. You are not allowed to use any books or notes or the like, i.e. the exam is “closed-books”. The final exam is cumulative, i.e. it covers all the material of the entire course.”

## Additional rules

- You must observe the University's Policy on Integrity of Scholarship, which can be found at <http://www-senate.ucsd.edu/manual/appendices/app2.htm>.
- Make-up exams (for both midterm and final) will only be given under the most severe circumstances. The student who wishes to write a make-up exam must inform me (by phone or email) ahead of the time of when the exam is due (midterm) or takes place (final). In order to qualify for a make-up exam, appropriate evidence of the most severe circumstances must be produced by the student. I will determine, in consultation with the student, what qualifies as appropriate evidence.

# What is philosophy of science?

- What is science and what distinguishes it from “pseudoscience”?
- What is the “scientific method”, if there is any, and on what basis can it claim to ensure the objectivity of scientific results?
- How does science explain our observations and experiences?
- Does scientific knowledge progressively grow in a linear fashion or is its evolution dominated by radical revolutions?
- Are the scientists’ grounds for rejecting an old idea and for replacing it with a novel theory completely rational and logically reconstructible or are they substantially influenced by irrational factors?
- Do scientific theories give literally true accounts of the world as it is, or should we regard even the most elaborate and well-confirmed theory merely as a useful tool to systematize our experience?



## Relevance of philosophy of science

“How does it happen that a properly endowed natural scientist comes to concern himself with epistemology? Is there no more valuable work in his specialty? I hear many of my colleagues saying, and I sense it from many more, that they feel this way. I cannot share this sentiment... Concepts that have proven useful in ordering things easily achieve such an authority over us that we forget their earthly origins and accept them as unalterable givens. Thus they come to be stamped as ‘necessities of thought,’ ‘a priori givens,’ etc. The path of scientific advance is often made impassable for a long time through such errors. For that reason, it is by no means an idle game if we become practiced in analyzing the long-commonplace concepts and revealing those circumstances upon which their justification and usefulness depend, how they have grown up, individually, out of the givens of experience. By this means, their all-too-great authority will be broken.”

Albert Einstein, Obituary for Ernst Mach (1916). *Phys. Z.* 17: 101f

Einstein to Robert A. Thornton, 7 December 1944, EA 61-574

“I fully agree with you about the significance and educational value of methodology as well as history and philosophy of science. So many people today - and even professional scientists - seem to me like somebody who has seen thousands of trees but has never seen a forest. A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is - in my opinion - the mark of distinction between a mere artisan or specialist and a real seeker after truth.”

## The programme of the course

3 April: A brief history of philosophy of science

8 April: Demarcating science vis-à-vis pseudoscience

10 April: Logical Empiricism

15 April: Explanation: D-N model (and I-S model)

17 April: Explanation, reduction, unification

22 April: Laws of Nature

24 April: Induction and confirmation

29 April: Underdetermination and holism

1 May: Popper's falsificationism

- 6 May: Kuhn and normal science
- 8 May: Kuhn and revolutions
- 13 May: Lakatos, Feyerabend
- 15 May: The challenge from sociology of science
- 20 May: Feminism and science studies
- 22 May: Naturalistic philosophy
- 27 May: Naturalism and the social structure of science
- 29 May: Bayesianism
- 3 June: Scientific realism
- 5 June: Overview and conclusion
- Finals: Final Exam, time TBA, location TBA

# A brief (and grossly incomplete) history of philosophy of science

# Ancient Greece and Aristotle (384-322 BCE)



- first elements of inductive scientific methodology in Greek Antiquity
- Aristotle believed that to know a thing's nature is to know the reason why it is and that we possess scientific knowledge of a thing only when we know its cause
- idea of generalization from particular observation to universal law of nature, and back from universal law to particular prediction
- continuity of philosophical and "scientific" work

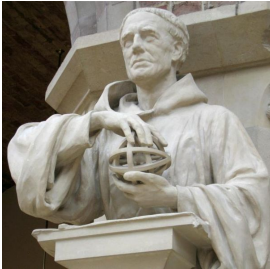
“Thus it is clear that we must get to know the primary premisses by induction; for the method by which even sense-perception implants the universal is inductive. Now of the thinking states by which we grasp truth, some are unfailingly true, others admit of error-opinion... There will be no scientific knowledge of the primary premisses, and since except intuition nothing can be truer than scientific knowledge, it will be intuition that apprehends the primary premisses—a result which also follows from the fact that demonstration cannot be the originative source of demonstration, nor, consequently, scientific knowledge of scientific knowledge. If, therefore, it is the only other kind of true thinking except scientific knowing, intuition will be the originative source of scientific knowledge. And the originative source of science grasps the original basic premiss, while science as a whole is similarly related as originative source to the whole body of fact.” (Posterior Analytics II, 19)

# Robert Grosseteste (1175-1253), Bishop of Lincoln



- “the real founder of the tradition of scientific thought in mediæval Oxford” (A C Crombie)
- first to fully grasp Aristotelian methodology in West
- explained generalization from observation to law and back to prediction via notions of “resolution” and “composition”
- principles governing both paths must be verified by observation and experimentation

# Roger Bacon (c. 1214-1294), “Doctor mirabilis”



- delivered philosophical justification for experimentation and observation (rather than reliance on authority) as the source of true knowledge in scientific and theological matters
- premises of experimental sciences require verification by sciences more perfect than themselves, i.e. by mathematics
- “If in other sciences we should arrive at certainty without doubt and truth without error, it behooves us to place the foundations of knowledge in mathematics.” (*Opus majus*, I, Part IV “On Mathematical Science”, 1268)

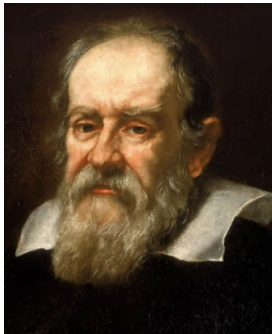
“There are two ways of acquiring knowledge, one through reason, the other by experiment. Argument reaches a conclusion and compels us to admit it, but it neither makes us certain nor so annihilates doubt that the mind rests calm in the intuition of truth, unless it finds this certitude by way of experience. Thus many have arguments toward attainable facts, but because they have not experienced them, they overlook them and neither avoid a harmful nor follow a beneficial course. Even if a man that has never seen fire, proves by good reasoning that fire burns, and devours and destroys things, nevertheless the mind of one hearing his arguments would never be convinced, nor would he avoid fire until he puts his hand or some combustible thing into it in order to prove by experiment what the argument taught. But after the fact of combustion is experienced, the mind is satisfied and lies calm in the certainty of truth. Hence argument is not enough, but experience is.” (*Opus majus*, II, Part VI “On Experimental Science”, 1268)

# Sir Francis Bacon (1561-1626), 1st Viscount St Alban



- systematic establishment and popularization of inductive methodology
- *Novum Organum*, 1620
- argued that reasoning from fact to axiom to law must be *inductive*, rather than *deductive* (as was the case in the Aristotelian tradition)
- induction alone is insufficient, negative instances must be carefully examined (early principle of falsification)
- reproducibility of scientific findings
- natural laws, not mysterious substances or final causes, have explanatory power
- human (and therefore scientific) knowledge is cumulative; as contrasted by given a priori (in Scripture or Aristotelian texts)

# Galileo Galilei (1564-1642)



- concerned with the *quantification* of experimental results (unlike e.g. William Gilbert)
- introduced *time* as a physical parameter to measure motion quantitatively
- insisted on the mathematical nature of laws of nature

“Philosophy is written in this grand book—I mean the universe—which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth.” (// *Saggiatore* (The Assayer), 1623)