

Galileo to Einstein
IPHS 292
Benjamin Schumacher

Class meeting: TTh 2:40 - 4:00 pm
Ascension 125

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This course is a look at the development and implications of science, focusing on two pivotal figures in the history of physics: Galileo Galilei and Albert Einstein. Galileo's writings helped to establish modern scientific thought; three hundred years later, Einstein's work on relativity and quantum theory helped to transform it. We will use the work of these two men as a springboard to discuss the nature of the scientific enterprise, the significance of scientific ideas for our view of the world, and the impact of science on the wider culture.

Elements of the course

Class meetings. We will meet for discussion and the occasional brief lecture on Tuesdays and Thursdays from 2:40 to 4:00 pm in Ascension 125. Attendance and active participation are expected. (We will not have class on Thursday, 6 April.)

Readings. We will draw our readings from the course texts, which are:

Dolling et al., eds.	<i>The Tests of Time</i>
Hawking, ed.	<i>On the Shoulders of Giants</i>
Galileo	<i>Discoveries and Opinions of Galileo</i>
Galileo	<i>Dialogue Concerning the Two Chief World Systems</i>
Einstein and Infeld	<i>The Evolution of Physics</i>
Einstein	<i>Ideas and Opinions</i>

Each week, you will be assigned sections from one or more of these, which should be read by Tuesday. Occasionally, I may also place a short supplemental reading on reserve in the library. I will try to keep the weekly reading assignment within reasonable bounds, and I'll indicate when parts of a selection can safely be skimmed. The provisional detailed list of readings will be handed out in class on Thursday, 19 January.

Response notes. On Thursdays I will send to you a short list of questions and ideas to ponder as you do the next reading assignment. By the next Tuesday at 9 am, you will send me via email an informal paper (a "response note") with your own comments and observations about the reading. This paper should be at least a page (250 words) in length but need not be very much longer; you can either submit it in the body of the email text or as an attachment in any format readable by Microsoft Word. (Please put the text "G2E" somewhere in the subject line of the mail message.)

I will assign each note a grade between 0 and 3, and then I'll comb through them and select some excerpts to share with the class. We'll use this weekly digest as a basis for class discussion.

Papers. There will be two papers in this course.

The **minor paper** will be 4-8 pages (1000-2000 words) in length. It will be a discussion of some issue that arises from one or more of Galileo's writings. Later I'll provide a list of suggested questions, or you can construct your own. The topic must be chosen by 16 February 2006 and the paper will be due by class time on 28 February 2006.

The **major paper** will be 10-15 pages (2500-4000 words) in length. This is a research paper on a topic in how the development of physical science has interacted with the wider culture (including interactions with religion, ethics, philosophy, literature, etc.). You should be on the lookout for interesting topics for this paper.

- *Selection of topic:* In consultation with me, you should settle on a general topic for the major paper by class time on Thursday, 30 March. (Topic selection by itself is worth 10% of the final grade on the major paper.)
- *The "weigh-in" conference:* During the week of 24-28 April, you will make individual 30-minute appointments with me. You'll bring copies of your sources, your research notes and any initial drafts of your paper. We will discuss what you've learned, how the paper is shaping up, and what further work still needs to be done. (The "weigh-in" conference is worth 15% of the grade on the paper.)
- *Paper:* Final drafts of your paper will be due on our last day of class, 4 May. (This is worth the remaining 75% of the grade on the major paper.)

Mid-term exam. The mid-term exam will be held during class on Thursday, 2 March.

Final exam. The final exam will be held at 8:30 am on 9 May, and will last three hours.

Grades. The course elements will contribute to the final grade as follows:

Class attendance response notes	40%
Papers: minor	10%
major	25%
Mid-term exam	10%
Final exam	15%

Other matters

Academic honesty. Should you be unclear about the College's policies on academic honesty, I strongly urge you to review them in the *Course of Study*. Plagiarism is a serious offense that could result in a failing grade for the course, or worse. The general principles are: (1) I strongly encourage discussion about readings and assignments, but all written work must be your own. (2) Reading and making use of outside sources is also encouraged, but you should properly cite those sources in any work that you turn in. Please ask me if you have any questions about how these rules apply to our work here.

Disabilities. If you have a physical, psychological, medical, or learning disability that may impact your ability to carry out assigned course work, you must contact the Office of Disability Services at 427-5453. The Coordinator of Disability Services, Erin Salva (salvae@kenyon.edu), will review your concerns and work with you to determine what accommodations are appropriate. All information and documentation of disability are confidential. No accommodations can be granted in this course without notification from the Office of Disability Services.

Contact information. My office is Hayes 208, on the second floor of the building on the north side of the Science Quad. My scheduled office hours are Monday and Wednesdays 9-11 am and Fridays 9-10 am. I'm also available at other times by appointment. I am also sometimes in the laboratory (Hayes 205/207) immediately across the hall from my office.

My office phone number is 427-5832 and my home phone number is 427-4292. (We tend to turn in early around our house, so try not to call much after 10 pm.) My email address is schumacherb@kenyon.edu. I generally check email between one and three times per day during the week, and less frequently on the weekends.

Reading assignments for IPHS 292: Galileo to Einstein

- *Tests* = *The Tests of Time: Readings in the Development of Physical Theory* (Dolling, Gianelli and Statile, eds.)
- *Shoulders* = *On the Shoulders of Giants: The Great Works of Physics and Astronomy* (Hawking, ed.)
- *Discoveries* = *Discoveries and Opinions of Galileo* (Drake, trans.)
- *Dialogue* = *Dialogue Concerning the Two Chief World Systems* (Drake, trans.)
- *Evolution* = *The Evolution of Physics: From Early Concepts to Relativity and Quanta* (Einstein and Infeld)
- *Ideas* = *Ideas and Opinions* (Einstein)

Note that (*) indicates a due date for Response Notes (see Syllabus)

17 January	<i>Introductory discussion</i>
19 January	Heliocentric introduction (<i>Tests</i> , pp. 3-13) Aristotle, "On the Heavens" (<i>Tests</i> , pp.13-26) Claudius Ptolemy, "Almagest" (<i>Tests</i> , pp. 29-38)
24 January (*)	Archimedes, "The Sand Reckoner" (<i>Tests</i> , pp. 26-28) Copernicus, "Commentary" (<i>Tests</i> , pp. 38-42) Kepler, "Epitome" (<i>Tests</i> , pp. 99-108) Galileo, "The Starry Messenger" (<i>Discoveries</i> , pp. 1-58)
26 January	<i>Continue discussion</i>
31 January (*)	Galileo, "Letters on Sunspots" (<i>Discoveries</i> , pp. 59-144) Galileo, "Letter to the Grand Duchess Christina" (<i>Discoveries</i> , pp. 145-216)
2 February	<i>Continue discussion</i>
7 February (*)	Galileo, <i>Dialogue</i> , pp. 1-275 (detailed reading instructions later)
9 February	<i>Continue discussion</i>
14 February (*)	Galileo, <i>Dialogue</i> , pp. 276-465 (detailed reading instructions later)
16 February	<i>Continue discussion</i>
21 February (*)	Galileo, "Two New Sciences" (<i>Shoulders</i> , pp. 399-626). Skim the whole, but more carefully read sections 50-53, 87-89, 105-113, 197-204, 273-284.
23 February	<i>Continue discussion.</i>
28 February	<i>Continue discussion. No additional readings. Minor paper due.</i>
2 March	Midterm exam

21 March (*)	<p>“The Rise of the Mechanical View” (<i>Evolution</i>, pp. 1-65)</p> <p>Newton, excerpts from the <i>Principia</i> (<i>Tests</i>, pp. 114-128) (<i>Shoulders</i>, pp. 725-755.)</p>
23 March	<i>Continue discussion</i>
28 March (*)	<p>“The Decline of the Mechanical View” and the first part of “Field, Relativity” (<i>Evolution</i>, pp. 66-153)</p> <p>Young, “The Interference of Light” (<i>Tests</i>, pp. 193-197; skim all of 179-201)</p> <p>Maxwell, “The medium for electromagnetic action” (<i>Tests</i>, pp. 235-245)</p> <p>Maxwell, “The ether” (<i>Tests</i>, pp. 265-273)</p> <p>Einstein, “Maxwell’s influence” (<i>Ideas</i>, 291-295)</p>
30 March	<i>Continue discussion</i> ; Major paper topic due
4 April	<p>Next part of “Field, Relativity” (<i>Evolution</i>, pp. 153-208)</p> <p>Einstein, excerpt from “On the Electrodynamics of Moving Bodies” (<i>Shoulders</i>, pp. 1167-1171)</p>
6 April	<i>No class meeting</i>
11 April (*)	<p>Einstein, excerpt from <i>Relativity</i> (<i>Tests</i>, pp. 313-330)</p> <p>Last part of “Field, Relativity” (<i>Evolution</i>, pp. 209-245)</p> <p>Eddington, “The bending of light rays” (<i>Tests</i>, pp. 330-339)</p> <p>Einstein, “Ether and relativity” (<i>Tests</i>, pp. 340-346)</p> <p>Einstein, “Geometry and experience” (<i>Ideas</i>, pp. 254-268)</p>
13 April	<i>Continue discussion</i>
18 April (*)	Einstein, readings in <i>Ideas</i> , including pieces on the following pages: 296-303, 318-356, 370-372, 244-248, 39-57
20 April	<i>Continue discussion</i>
25 April (*)	<p>“Quanta” (<i>Evolution</i>, pp. 249-297)</p> <p>Bohr-Einstein debate (<i>Tests</i>, pp. 406-437)</p>
27 April	<i>Continue discussion</i>
2 May (*)	Einstein, readings in <i>Ideas</i> , including pieces on the following pages: 3-39, 63-69, 91-92, 104-114, 129-160, 165-173, 218-221
4 May	<i>Continue discussion</i> ; Major paper due