

ACS Reform of Introductory Science courses for Non-Majors Course Mini-grants
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Key Figures in Modern Physics

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Summary

Issue Addressed by the Proposal:

Physics 17, Survey of Physics for Non-Science Majors, exists in Furman's curriculum as a course that will satisfy one of the two physical science requirements in the general education requirement. In the most recent offering of this course “Physics, Concepts and Connections” by Art Hobson has been used. This text presents an excellent survey of all of physics. In previous offerings “From Alchemy to Quarks” by Sheldon Glashow has been used.

These standard non-science major texts focus on physics and the ways in which science and society have interacted. While the existing course does a great deal to present physics in context, it fails to encourage discussion and it does not fully engage the non-science majors with the historical and philosophic context of the scientific discoveries. At present the course includes neither a laboratory experience nor a written essay requirement.

Goals and Objectives of the Proposal:

This proposal will adapt the current course to make it more engaging to non-science majors by presenting scientific material in a context that is already familiar to them. Specifically it would add five modules to the existing course, each one focusing on a single individual who made outstanding contributions not only to science but also to history. The scientific achievements made by each of these individuals will be discussed

within the context of the historical, political, religious and logistical struggles of their time. The five individuals selected for the modules are Thomas Jefferson, Benjamin Franklin, James Clerk Maxwell, Albert Einstein and Robert Oppenheimer. The goal is to stimulate good discussion (both in class and in writing assignments) of scientific discovery as viewed through the eyes of both the scientists and their contemporaries. In some cases appropriate lab activities that reproduce important discoveries will be conducted.

Anticipated Outcomes:

Students will develop a greater scientific literacy through discussion and writing. Also students majoring in philosophy, history, education, humanities, political science and the like will be able to easily incorporate the material learned in this course into their own disciplines.

Possible Collaboration:

Furman is considering changing its curriculum to include a freshman seminar. If this change is adopted, this course may be developed to become part of this seminar. A two course interdisciplinary sequence that involves history and physics represents an exciting possibility.

Project Description

The primary goal of this project is to increase scientific literacy through a direct engagement of students with the primary work and activity of key scientific/historical figures. Each of these figures made significant contributions, and their personal struggles provide significant insight into their discoveries.

Students will be assigned a series of questions to be researched through readings of primary documents on the web site dedicated to this course. The syllabus will include discussion time for each module. In addition, each student will complete a research paper based on one or more of the modules.

In addition to the science texts, the modules will contain primary documents such as correspondence and articles as well as materials created by contemporaries.

Details of The Modules

I. Benjamin Franklin

Benjamin Franklin is a major figure in the American and French revolutions. He is the only person to sign all four of the major documents that created the United States. These documents include the Declaration of Independence, The Treaty of Alliance, Amity and Commerce with France, The Treaty of Peace Between England, France and the US, and the Constitution.

This module will include documentation of Franklin's electricity experiments. These experiments are wonderfully described in a well-preserved set of letters written to Peter Collinson in London and are accessible on line through the Franklin Institute.

Of particular interest are the experiments with lightening rods. Franklin viewed lightening rods as a possible source of electrical energy as well as a method of protecting ships and buildings from lightening strikes.

Students will be able to read the original description of his activities and will then be able to go into the physics laboratory and reproduce some important results with safe, modern lab activities developed for this course. Documents from England, where the king declared that rods be constructed with blunt rather than the sharpened ends Franklin proved better, are especially interesting. The laws of physics could not be changed by royal decree.

II. Thomas Jefferson

Thomas Jefferson, perhaps more than any other person, epitomizes the love of reason that developed in the eighteenth century. His personal collection of books and manuscripts are well-documented through his gifts to the Library of Congress as well as inventories at Monticello. His move to replace superstition with science is especially important both politically as well as scientifically. Hence his personal reflections on important scientific works of his day represent key features in the intellectual landscape of his time.

Students will access these reflections through letters and articles available on line from Monticello.

Monticello is especially accessible to those interested in Jefferson. Part of the activities associated with this grant will be a trip to Monticello to photograph key architectural features that reflect his love of technology and reason.

III. James Clerk Maxwell

James Clerk Maxwell is the father of modern theoretical physics. His electromagnetic field theory laid the foundations of the two great theories of the twentieth century—relativity and quantum theory. His theory also provided the tools to create the technical age⁴.

Maxwell's theory was much more than a synthesis of what was known before. His theory also represents a fundamental change in concept that departed from Newton's view.

Maxwell's comprehensive theory was not immediately accepted. For more than a decade there was little experimental evidence to support it and his personal correspondence reflects his efforts to advance this radical new concept.

After reading the debate about the new theory, students will recreate the experiments conducted by Heinrich Hertz in the laboratory. These experiments were developed for

freshman physics lab at MIT and demonstrate the wave properties predicted by his theory.

IV. Albert Einstein

From the confirmation of his theory of general relativity during a total eclipse of the sun in 1919 until his death, Albert Einstein was the most famous living scientist. Einstein, however, is much less well known as the advocate of a number of unpopular causes.

The Center for the History of Physics, maintained by the American Institute of Physics, has many of Einstein's papers and articles on line. His essay, "The World as I See It", gives fundamental insight into his views of science and his strong support of pacifism. There are also articles on line explaining his beliefs that the first World War I could and should have been avoided.

The contrast between these early writings and the famous letter that he signed and sent to Roosevelt are striking. This letter, written with Leo Szillard, advocates the effort that eventually produced the atomic bomb. The trail of circumstances that led this motivated and ardent pacifist to advocate the development of weapons of mass destruction provides significant insight to the holocaust and World War II.

V. Robert Oppenheimer

The explosion of the first atomic bomb marked a new age in human history. Robert Oppenheimer, more than any other, made this remarkable technical achievement possible. While his scientific and political accomplishments prior to the Trinity Test are many and remarkable, Oppenheimer is also a central and tragic figure in the McCarthy era. The many documents surrounding the removal of his security clearance provide key insight into this scientific and political movement. Forged documents produced by his former friend Edward Teller are especially interesting. These documents crushed Oppenheimer and removed all obstacles hindering the development of the Hydrogen bomb.

His own letters, which reveal a series of bad personal decisions, demonstrate the origin of the many paradoxical descriptions him. The reports of the many FBI agents who shadowed him and the evidence fabricated by Teller provide direct insight to the arms race and the cold war.

Projected Timetable

June 13-17	Research potential documents for Franklin Module
20-24	Develop Electricity Lab Exercise
June 27- July 1	Research potential documents for Jefferson Module
11-15	Trip to Monticello
18-22	Research potential documents for Maxwell Module
25-29	Develop radio wave lab exercises

August 1-5 Research potential documents for Einstein Module
 8-12 Research potential documents for Oppenheimer Module
January 5-February 21 Prepare course Web site and links

(the 2005-2006 schedule for the Physics department has been arranged so that the applicant has no teaching duties during January and February)

Evaluation and Dissemination

The students will evaluate the course with a special additional set of questions distributed during the normal student evaluation. The results will be disseminated through a website, as well as papers submitted to the ACS and the **Physics Teacher**.

Sources and Literature Cited

Franklin

The Franklin Institute, Philadelphia, Pa

Jefferson

Monticello on line, Charlottesville, Pa

Maxwell

L Campbell and W. Garnett *The Life of James Clerk Maxwell with selections from his correspondence and occasional writings* (London, 1884)

P M Harman *The scientific letter and papers of James Clerk Maxwell, Vols I and II* (Cambridge, 1990, 1995)

Melvyn Bragg *Who was James Clerk Maxwell?* (BBC Radio, London)

Einstein

The Center for the History of Physics, American Institute of Physics

Oppenheimer

Oppenheimer: A Life (online centennial exhibit, University of California, Berkeley)

United States Atomic Energy Commission in the Matter of J. Robert Oppenheimer (The Avalon Project at Yale Law School)

NP Davis *Lawrence and Oppenheimer* (Simon and Schuster, 1986)

II Rabi *Oppenheimer* (Scribner, 1969)

Disclosure: The applicant has no other grant applications under consideration.