Physics 12: Physics for Poets

(Everything You've Wanted to Know about Einstein's Work, But Were Afraid to Ask)

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This non-mathematical introduction to the ideas of modern physics is designed for those not majoring in the physical sciences. After a brief introduction to the history and ideas of physics in general and atomic theory specifically, the course focuses on three areas of modern physics that have revolutionized our understanding of nature: thermodynamics and the concept of entropy, Einstein's special and general theories of relativity, and quantum mechanics. In the process we will get to know some of the key people involved in these fields, particularly Albert Einstein. We also examine (briefly) the impact these physics ideas have had on other fields, such as poetry, literature, and music. No background in science or math will be assumed.

Topics Covered:

A. Introduction to Science and the Cosmos
   1. The nature of science and the scientific method
   2. A Grand Tour of the Physical Universe

B. What's Everything Made Of
   1. The History of Atomic Theory
   2. Einstein's Work on Brownian Motion

C. Classical Physics
   1. The beginnings of physics -- Galileo and the experimental method
   2. Newton's Laws: The Constitution of the Universe
   3. Work, Energy, Power
   4. Classical Gravitation

D. Thermodynamics and Entropy
   1. Heat and Temperature
   2. The Laws of Thermodynamics
   3. Entropy and the Second Law of Thermodynamics
   4. The Arrow of Time and the Ultimate Fate of the Universe
   5. Reflections in Literature

E. The Life and Time of Albert Einstein
   1. Brief biographical overview
   2. Einstein's views of science and the world

F. The Special Theory of Relativity
   1. Time Dilation, Lorentz-Fitzgerald Contraction, the Guillotine Problem

2. The role of mass and energy
3. The meaning of $E = mc^2$
4. Realistic Space Travel as an Illustration of Special Relativity Theory

G. The General Theory of Relativity
1. The "warping" of space-time
2. Black Holes
3. Time Machines in Science: Using General Relativity

H. Einstein, Relativity and the Rest of Human Culture
1. Images of Einstein in popular culture & the public view of scientists
2. Relativity in fiction

I. Quantum Mechanics
1. The nature of light -- a historical development: waves versus particles
2. The nature of matter -- waves versus particles
3. The uncertainty principle and its implications
4. Probabilistic interpretations of nature: Does God Play Dice with the Universe?
5. The Many-Worlds Interpretation (briefly)
6. Quantum Mechanics in Literature

J. Recent Developments
1. Stephen Hawking's work combining relativity & quantum mechanics
2. Quantum black holes

Required Readings:

1. *Textbook:* Spielberg, N. & Anderson, B. *Seven Ideas that Shook the Universe,* 2nd ed.

2. *The Fiction:* I ask that you read one of the following two novels:
Thomas Pynchon: *The Crying of Lot 49* (goes with thermodynamics)
Robert Coover: *The Universal Baseball Association* (quantum mechanics)

3. In addition, I will distribute further reading assignments in the form of short stories, poems, etc. Please note that the fiction will appear on the quizzes and exams in the later part of the course, so you may not want to take the class if you hate reading fiction!

Course Requirements:

1. Attendance counts for your grade. You must attend class regularly and arrive promptly to get the full benefit of the lectures, discussions, and demonstrations.

2. There will be one midterm and one final exam, for which you will be able to bring a 3x5 card of notes. In addition, there will be quizzes, both announced and unannounced. You must bring a #2 pencil and a Scantron sheet [Form 882] to each class.

3. Please bear in mind this is a college course. The responsibility for attendance, doing assignments by the announced deadlines, getting any missed lecture notes, etc. rest entirely with you. The instructor *strongly* recommends that students form study groups during the quarter and work together. It will be very useful to take notes during all class sessions.

Grades: Grades will be computed according to the following formula: Midterm = 25%, Final = 45%, Quizzes = 20%, Attendance = 5% or more.

Office Hours: Office Hours will be held during the half hour before each class (5:30 to 6 pm, Tuesday and Thursday). Appointments at other times can be made in advance by telephone or in person. Don't hesitate to let me know if you are having problems (or if -- GASP! -- you are having a good time) in the class.

Library Reserve: Many materials to help students with the course or with pursuing their own interests in physics are on reserve in the instructor's name in the Foothill Library. Don't hesitate to ask me for additional reading suggestions on any of the course topics (including good science fiction stories to read.) Students will also receive a much fuller reading list on the topics of the course and fun examples of fiction and science fiction inspired by these topics.

About the Instructor:

Andrew Fraknoi is the Chair of the Astronomy Department at Foothill College, as well as the lead author of one of the most popular astronomy textbooks in the U.S., *Voyages through the Universe*. He appears regularly on local and national radio, bringing new developments in astronomy "down to earth." For years, he has offered weekend programs on Einstein's work through the University of California Extension and has been invited to do a major program on Einstein at the New York City Public Library as part of the celebrations of the Centennial of Relativity. Recently, he became the first community college instructor to be voted a Fellow of the California Academy of Sciences. Asteroid 4859 has been named Asteroid Fraknoi by the International Astronomical Union in recognition of his contributions to the public understanding of science.