Peripherals

★I am ...

★You are ...

★Syllabus

★Questions

http://wuphys.wustl.edu/~wimd
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• Who is afraid of physics?
• Not a math course but quantitative

The learning bill of rights

I have the right to learn at my own pace and not feel put down or stupid if I am slower than someone else
I have the right to ask whatever questions I have
I have the right to need extra help
I have the right to ask a teacher or a TA for help
I have the right to say I don’t understand
I have the right not to understand
I have the right to feel good about myself regardless of my abilities in a particular subject
I have the right to evaluate my instructors and my textbooks
I have the right to relax
I have the right to be treated as a competent adult
I have the right to dislike a subject
Course goals

Students will:

- learn how science (in particular physics) makes progress and the roles played by theory and experiment
- learn the distinction between “good” and “bad” science, using examples from both past and present
- understand some of the limitations of science
- be able to use the concepts of energy and power quantitatively and solve simple problems
  involving, e.g., windmills, dams, and catastrophic events
- learn the importance and limitations of energy efficiency
- know how conventional energy plants work
- understand the origin of fossil fuels and the likely extent of available resources
- gain insight into the history of energy consumption and modern society’s pattern of consumption
- understand the production of nuclear energy and the workings of a nuclear reactor
- be able to distinguish various forms of radioactivity and know the meaning of radiation dosage units
- become informed on various topics related to nuclear energy and public concern: proliferation, terrorism,
  safety of nuclear reactors, radioactive waste disposal
- learn the biological effects of exposure to radiation
- know what the consequences of a nuclear explosion are
- learn the basic ingredients of the Greenhouse effect
- appreciate the relation of Greenhouse gases to fossil fuels
- learn about the possible consequences of global climate change
- learn the role of CFC’s in Ozone destruction and the present status of ozone-related problems
- become familiar with the prospects for alternative, renewable energy sources
- understand the global nature of some science and technology policy issues
- have an increased awareness of issues related to science and society
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<tr>
<th>Topic</th>
<th>Date</th>
<th>Problem Sets</th>
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<tr>
<td>1 Good Science</td>
<td>8/28/08</td>
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<td>2 Bad Science</td>
<td>9/2/08</td>
<td>#1 out</td>
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<td>3 Gravitational and Kinetic Energy</td>
<td>9/4/08</td>
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<td>4 Energy Conservation and Power</td>
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<td>5 Heat Engines and the 2nd Law</td>
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<td>6 Coal and Electric Power Generation</td>
<td>9/16/08</td>
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<td>7 Energy: National and International Trends</td>
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<td>8 The End of Oil?</td>
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<td>9 Fossil Fuels: Prospects and Policy</td>
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<td>10 Clean Energy: Sun and Water</td>
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<td>11 Clean Energy: Wind and Sun</td>
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<td>12 Clean Energy: Hydrogen and Biofuels</td>
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<td>13 Catastrophe and Risk: Natural Disasters</td>
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<td>14 Catastrophe and Risk: Terrorism</td>
<td>10/14/08</td>
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<td><strong>15 First Exam (in class)</strong></td>
<td><strong>10/16/08</strong>*</td>
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*Fall Break ...
16 Blackbody Radiation and Temperature 10/21/08
17 The Greenhouse Effect 10/23/08 #7 due; #8 out
18 Modeling Climate Change 10/28/08
19 Future Climates 10/30/08 #8 due; #9 out
20 Radiation and Radioactive Decay 11/4/08
21 Fission and Fusion 11/6/08 #9 due; #10 out
22 Biological Effects of Radiation 11/11/08
23 Nuclear Reactors 11/13/08 #10 due; #11 out
24 Reactor Disasters and Waste 11/18/08
25 Nuclear Weapons 11/20/08* #11 due; #12 out
26 Nuclear Proliferation 11/25/08
27 Last class 12/2/08
28 2nd Exam (in class) 12/4/08 #12 due
Physics 171 has no prerequisite, and is suitable for both science and non-science majors. It is a key course in cluster CL1784 (Physics: its relevance for the modern age) and is also a part CL1714. The course fulfills the QA requirement of A&S, the NSM for FA, and the SCI for BU. Wherever possible, we will use simple quantitative analysis, and you will learn about risk analysis, interpolation and extrapolation, exponential growth and decay, unit conversions, and back-of-the-envelope estimation. The level of mathematics is modest, but you will want a scientific calculator.
Requirements

This course must be taken for a letter grade; the CR/NC option is not available. Course grades will be based on 12 written assignments and two 1.5-hour tests. The first test will be given in class on October 16th, 2008, in class. The second test will take place on December 4th, 2008, in class. The exams will partly determine whether factual information has been acquired; some of the questions will be in multiple-choice format, while others will require short answers of a paragraph. Much of the factual information will be presented in lectures. Some exam questions may relate to the required books for the course. Each examination will contribute 25% of the overall grade; the problem sets will make up the other 50%. Late assignments will not be accepted. As a rule, assignments are due one week after being handed out, and graded assignments are returned a week after they are handed in. Two homework assignments can be replaced by a two-page book report on one of the two assigned books for the course. Other extra credit assignments based on extracurricular events may be made available. Any such opportunities will be made available to the entire class.
Information on EnSt272A

Physics 171A may also be taken as Environmental Studies 272A. EnSt272A requires the preparation and presentation of a paper on an aspect of science and society.

Books

Required Books:  *The Weather Makers* by Tim Flannery
*Megawatts and Megatons* by Garwin & Charpak

These books may be purchased at the bookstore or elsewhere. These books serve as background reading material and will be required reading.

Recommended Technical Books:
- *Energy: Physical, Environmental, and Social Impact* by Aubrecht
- *Energy and the Environment* by Ristinen & Kraushaar
- *Energy: Principles, Problems, Alternatives* by Priest

These books are on “reserve” and available in the Physics Library, Compton 340.
You are encouraged to discuss the quantitative homework assignments with other students in the class. After such discussions, problem sets should be written up separately, and never copied. Students who copy will be referred to the academic integrity officer for the appropriate school. At all times, you must respect the academic integrity policies of the university. You must not receive or provide any unauthorized assistance on an exam. During the exams you will require a calculator (not a computer). Exams are closed book, closed notes.
Questions?

• How is science done?
• ......
Model of the Universe

- Earth fixed / Center of Universe
  - Aristotle 384-322 BCE
  - Moon, Sun, 5 planets on perfect spheres, stars fixed
  - Planets & stars circle earth (why?)
  - Can’t be right: Mars has retrograde motion, other planets as well
  - Track Mars, or Venus, or Mercury …
Aristotle’s universe
Ptolemy’s epicycles

- Ptolemy ~87- ~150 CE
- Epicycles to explain observations
- Moon problem: epicycle requires its distance to vary by factor of 2 (not observed)
- Each planet has its own cycle
- What do you think of this model?
- Moon inconsistent & no predictions!
Epicycles

- Center of deferent
- Earth
- Deferent
- Path of the planet
- Epicycle
Copernican Revolution

- Copernicus 1473-1543
- 1514 & 1543 De Revolutionibus
- Sun at the center
- Planets in circular orbit around the sun (wrong)
- Explains retrograde motion
- Simpler ⇒ Occam’s razor (later)
- Esthetics still played a role … as it did for Einstein!
Retrograde motion
towards Newton

• Tycho Brahe 1546-1601
  – Observed planetary motion as accurately as possible!

• Let data decide which is correct model or description

• Johannes Kepler 1571-1630

• First scientist to take data really seriously!!

• Orbits are ellipses …(1609-1619) and that’s not what he “wanted”
continued

• Galilei 1564-1642 principle of inertia
  – If nothing acts on an object and it is going in a straight line, it will go at the same velocity in the same straight line forever!

• Newton 1642-1726
  – Force needed to change velocity
    • In direction of motion: speed up or slow down
    • Perpendicular to direction of motion: change only direction of velocity

• Genius of Newton: Gravitational force explains planetary motion and the motion of the falling apple quantitatively!
Prediction

• First half 19th century
  – Mercury, Venus, Earth, Mars, Jupiter, Saturn, and Uranus (1781 accidental)
  – Corrections from mutual attraction of planets ⇒
    Jupiter & Saturn motion correct
  – Uranus not!

• Now what: get rid of gravity theory?
  – must be prepared to do so!!

• Prediction of Neptune by Adams & Leverrier:
  – Look there at that time: you will see a planet that is responsible for the required correction for Uranus!
  – 1846 Galle looked and found Neptune!!!!!!
So we conclude ...

- Goal of science: to find out how the universe works and what are the rules that govern the observed phenomena
- Not: Why it works the way it does?
- How does science proceed?
  - Observation / Recording (passive)
    - “honest” “careful” “unbiased”
  - Experimentation “controlled”
  - Construct hypothesis / model / theory to describe data
  - Predict new experiments
  - Checks predictions …
- No “cheating”
- Language: Mathematics
“Correct” way to do science

• Good theory should be consistent with known data
• Should be as simple as possible
• Should preferably be quantitative
• Should have a broad range of application
• Should predict and suggest new studies for further experimental and theoretical discoveries
• Should be “falsifiable”
  – Newton’s theory not valid for black holes ➔ Einstein
  – But General Relativity is equivalent for planetary motion so Newton is still used
  – Problem with String Theory ➔ Smolin
Comments

• Good science is not democratic!
  – Everybody is not entitled to his/her own belief
  – Self-correcting in principle

• Predictions but what kind?
  – Horoscope? Stock market? Coin toss? Even if correct, doesn’t mean it’s science
  – Should be testable (independently by different people)