Physics 9, January 29, 2008

- Course Description.
- Energy in the News.
- General Introduction of the concept of Energy.
- Sources and Uses of Energy.
- Why is Energy in Transition?
Energy In Transition

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Why take Physics 9?

Curiosity about Energy - What is it? How does it transform?

To gain practice at approaching real issues quantitatively.

To become more "Scientifically literate".

To have some fun while learning basic Physics.

To become more aware of our impact on the environment and what we can do about it.
Welcome sheet


• Energy and Introduction to Physics and Energy Facts and Figures, Robert Romer. (relevant text is available in the Physics department office for $61.50).
Assignments and Intellectual Responsibility

• Discuss various elements of the course.
• Discuss code of intellectual responsibility.
• Pass out assignment #1 and equipment.
# Tentative Physics 9 Syllabus
## Spring 2008

Tentative syllabus for Physics 9 for the Spring of 2008

? Marks refer to items that are uncertain at this time

Items in green are presently scheduled

All items are subject to change

<table>
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<tr>
<th>Week</th>
<th>Topics</th>
<th>Readings</th>
<th>Demos</th>
<th>HW-Projects</th>
<th>In-Class Lab</th>
<th>Guest Lectures/Trips/Films</th>
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<tr>
<td>29-Jan</td>
<td>Energy Forms/units/conversions/</td>
<td>E1, R1</td>
<td>shower heating</td>
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<tr>
<td>5-Feb</td>
<td>kinetic+potential energy</td>
<td>R2+R3 cannonball</td>
<td>Cons. Of Energy</td>
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<tr>
<td>12-Feb</td>
<td>laws of thermodynamics</td>
<td>E3.3,3.6 heat engines</td>
<td>Mech equiv. of heat</td>
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<tr>
<td>19-Feb</td>
<td>DC Electricity</td>
<td>R8</td>
<td>DC electric set</td>
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<tr>
<td>26-Feb</td>
<td>AC electricity/magnetism</td>
<td>R8</td>
<td>motor</td>
<td>motor kit</td>
<td>Elec equiv. of heat</td>
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<td>E3.4, R9 induction</td>
<td>generator kit</td>
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<td>11-Mar</td>
<td>Wind/Hydro/geothermal</td>
<td>E5</td>
<td>Wind: Manwell (Umass) 3/13</td>
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<td>25-Mar</td>
<td>recess</td>
<td>Power Plant visit 3/27 (8:30 AM)?</td>
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<td>1-Apr</td>
<td>Carbon based fuels</td>
<td>E2</td>
<td>radioactivity decay?</td>
<td>&quot;Chernobyl Heart&quot;?</td>
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<td>8-Apr</td>
<td>Nuclear</td>
<td>E6</td>
<td>&quot;The Power of the Sun&quot;?</td>
<td>Gregory (Evergreen Solar) 4/17</td>
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<td>15-Apr</td>
<td>Solar/Fuel cells</td>
<td>E4 Fuel Cell</td>
<td>solar cells</td>
<td>&quot;Inconvenient Truth&quot;?</td>
<td>Ethanol: Lynd (Dartmouth) 4/24</td>
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<td>22-Apr</td>
<td>Pollution, Global Warming</td>
<td>E9+10</td>
<td>final projects?</td>
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<td>29-Apr</td>
<td>Conservation, cogeneration</td>
<td>E7,8</td>
<td>Brassard (Amherst) 4/29</td>
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<td>6-May</td>
<td>summary</td>
<td>final projects?</td>
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R = Energy, an Introduction to Physics by Romer
E = Energy and the Environment, 2nd edition by Ristenen and Kraushaar
To build a future of energy security, we must trust in the creative genius of American researchers and entrepreneurs, and empower them to pioneer a new generation of clean energy technology. Our security, our prosperity, and our environment all require reducing our dependence on oil.

Last year, I asked you to pass legislation to reduce oil consumption over the next decade, and you responded. Together we should take the next steps. Let us fund new technologies that can generate coal power while capturing carbon emissions. Let us increase the use of renewable power and emissions-free nuclear power. Let us continue investing in advanced battery technology and renewable fuels to power the cars and trucks of the future. Let us create a new international clean technology fund, which will help developing nations like India and China make greater use of clean energy sources. And let us complete an international agreement that has the potential to slow, stop, and eventually reverse the growth of greenhouse gases.
This agreement will be effective only if it includes commitments by every major economy and gives none a free ride. The United States is committed to strengthening our energy security and confronting global climate change. And the best way to meet these goals is for America to continue leading the way toward the development of cleaner and more energy-efficient technology.

To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow. Last year Congress passed legislation supporting the American Competitiveness Initiative, but never followed through with the funding. This funding is essential to keeping our scientific edge. So I ask Congress to double federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on earth.
World Scientists Near Consensus on Warming
By JAMES KANTER and ANDREW C. REVKIN
PARIS, Jan. 29 — Scientists from across the world gathered Monday to hammer out the final details of an authoritative report on climate change that is expected to project centuries of rising temperatures and sea levels unless there are curbs in emissions of carbon dioxide and other gases that trap heat in the atmosphere. Scientists involved in writing or reviewing the report say it is nearly certain to conclude that there is at least a 90 percent chance that human-caused emissions are the main factor in warming since 1950. The report is the fourth since 1990 from the Intergovernmental Panel on Climate Change, which is overseen by the United Nations. The report, several of the authors said, will describe a growing body of evidence that warming is likely to cause a profound transformation of the planet.
Among the findings in recent drafts:
The Arctic Ocean could largely be devoid of sea ice during summer later in the century.
Europe’s Mediterranean shores could become barely habitable in summers, while the Alps could shift from snowy winter destinations to summer havens from the heat.
Growing seasons in temperate regions will expand, while droughts are likely to ravage further the semiarid regions of Africa and southern Asia.
The Preservation Predicament

By CORNELIA DEAN, NY Times, January 29, 2008

Conservation organizations that work to preserve biologically rich landscapes are confronting a painful realization: In an era of climate change, many of their efforts may be insufficient or beside the point.

Some scientists say efforts to re-establish or maintain salmon runs in Pacific Northwest streams will be of limited long-term benefit to the fish if warming makes the streams inhospitable. Others worry about efforts to restore the fresh water flow of the Everglades, given that much of it will be under water as sea level rises. Some geologists say it may be advisable to abandon efforts to preserve some fragile coastal barrier islands and focus instead on allowing coastal marshes to migrate inland, as sea level rises.
Any Other Bright Ideas?

Sylvania Halogen $4.99
An indoor-outdoor halogen bulb that emits a crisp, white light.

Sylvania Daylight $8.00 for a four-pack
An odd-looking, very long bulb with a cool, white light.

Norman Soft White $5.97
A compact fluorescent that emits a very white, natural-looking light.

Sylvania Day-Light Plus $3 to $4.99
A halogen bulb encased in heavy glass that emits a bright, natural-looking light.

American Lighting $4.99
An induction bulb that creates light with the help of a magnet and is expected to last for 27 years.

Sylvania Soft White Micro Mini $9.99 for a two-pack
A compact fluorescent that turns on instantly.

MaxLite Mini Bulb $6.00 to $6.99
A compact fluorescent tube under a frosted cover.

Osram ECO 60 $18.99 to $29.99
An unusually slim filament bulb.

Sylvania Smart-Bulb $11.00 to $15.00
A compact fluorescent that works with most dimmers.

Philips Halogen $9.97 for a two-pack
One of the only halogen bulbs that meets federal energy standards that will begin to take effect in 2012.

Greenlite 9W $1 to $2.25
A compact fluorescent from Canada that comes with a new-year guarantee.

Philips Saver 40 Ceiling Fan Bulb $2
A screwed compact fluorescent designed to work in ceiling fans.

Lemnis Lighting Pharo Bulb $8
A technologically advanced bulb that lights with an LED chip.
Any Other Bright Ideas?

By JULIE SCELFO, NYTimes, January 10, 2008

After more than eight months of intense deliberations between Congress and bulb manufacturers, environmental groups and other parties, a law that requires light bulbs to become more energy efficient became part of the energy bill that President Bush signed into law on Dec. 19.

Over a three-year period beginning in 2012, all new bulbs will have to use 25 percent to 30 percent less energy for the same light output as today’s typical incandescent bulbs. Given that the vast majority of bulbs now on the market that meet those standards are compact fluorescents, which use 70 percent less energy and last 6 to 10 times longer than incandescents, Americans may have little choice but to accept them as part of the future.
What is Energy?

It is the stuff that makes things go. (a friend’s definition)

The ability to do work. (Physics Definition).

Work = Force \cdot \text{distance}.

Force is what you measure with a scale (e.g. pounds).
Forms of Energy

- Kinetic = \( \frac{1}{2} mv^2 \). Energy of motion.
- Gravitational Potential = energy stored in raising an object up. \( U = Weight \times height = mgh \).
- Chemical = energy stored in molecular bonds.
- Nuclear = energy stored in nuclear bonds.
- Thermal = energy in molecular motion, vibration and rotation.
- Electrical = energy associated with stored and moving charges.
- Radiation = energy of electromagnetic waves.
- Mass Energy = \( mc^2 \).
Examples of Energy

- Kinetic
  A truck going down the road.

- Gravitational Potential
  Water at the top of a waterfall.

- Chemical
  Food, oil, battery

- Nuclear
  Reactor fission, fusion in the sun

- Thermal
  Hot water in your shower

- Electrical
  Toaster, computer, TV.

- Radiation
  Sunlight

- Mass Energy
  The annihilation of a particle and its antiparticle.
Sources of Energy

- Sun
- Fossil fuels
- Biomass - Food
- Hydroelectric
- Nuclear reactions - Geothermal
- Wind
Energy Consumption by Source, 1635-2006 (QBtu)
Energy Consumption History and Outlook, 1949-2030
How does Energy get used?

• Transportation - to move things and people.
• Industrial - to make things.
• Residential - heating, lighting and appliances.
• Commercial - offices and stores.
U.S. Primary Energy Consumption by Source and Sector, 2006
(Quadrillion Btu)

**Petroleum**
- Source: 39.8
- Sector: 69%
  - Transportation: 28.3
  - Industrial: 21.6
  - Residential and Commercial: 10.3

**Natural Gas**
- Source: 22.4
- Sector: 37%
  - Transportation: 8%
  - Industrial: 37
  - Residential and Commercial: 6%

**Coal**
- Source: 22.6
- Sector: 9%
  - Transportation: 21%
  - Industrial: 21%
  - Residential and Commercial: 7%

**Renewable Energy**
- Source: 6.8
- Sector: 56%
  - Transportation: 56%
  - Industrial: 2
  - Residential and Commercial: 9

**Nuclear Electric Power**
- Source: 8.2
- Sector: 100%
  - Transportation: 21
  - Industrial: 52
  - Residential and Commercial: 3

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1. Excludes 0.5 quadrillion Btu of ethanol, which is included in "Renewable Energy."
2. Excludes supplemental gaseous fuels.
3. Includes 0.1 quadrillion Btu of coal coke net imports.
5. Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
6. Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
7. Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.
Sources: Energy Information Administration, Annual Energy Review 2006, Tables 1.3, 2.1b-2.1f, and 10.3.
Why is “Energy in Transition”?

US consumption rate of Oil = 7 Billion barrels/year

Known US oil reserves = 30 Billion barrels

If we used only our own oil how long would this last?

30 Billion barrels/(7 Billion barrels/Year) = about 4 years!
But what about the world?

- Known global oil supply is about 1,000 billion barrels
- World consumption rate = 30 billion barrels/year.

\[ \frac{1,000 \text{ billion barrels}}{30 \text{ billion barrels/year}} = 33 \text{ years}. \]
Interesting note

- US has about 3% of the known oil reserves.
- US is responsible for about 25% of the world's oil consumption.
- US population (291 Million)
  World population (6.5 Billion)
  Less than 3% of the world population.
Comparison between discovery and consumption

Discovery, gbp

Extrapolation
Consumption
IEA forecast

Consumption, gbp
How Soon Will Oil Supplies Peak?

(Christian Science Monitor), Nov. 9, 2005  by John Dillin.

"By their nature, the people who explore for oil [like ExxonMobil] are optimists. They have to be, but we are betting our [American] civilization on the assumption that they are right. "Robert Hirsch, SAIC

If world crude-oil production hits its peak and then falls within the next five to 10 years, would America be ready? The answer is, almost certainly not.
Greenhouse Gas Emissions, Based on Global Warming Potential

- **Total**
- **Carbon Dioxide**
- **Other¹**

![Graph showing the increase in greenhouse gas emissions from 1980 to 2005](image)
US Natural Gas consumption and production