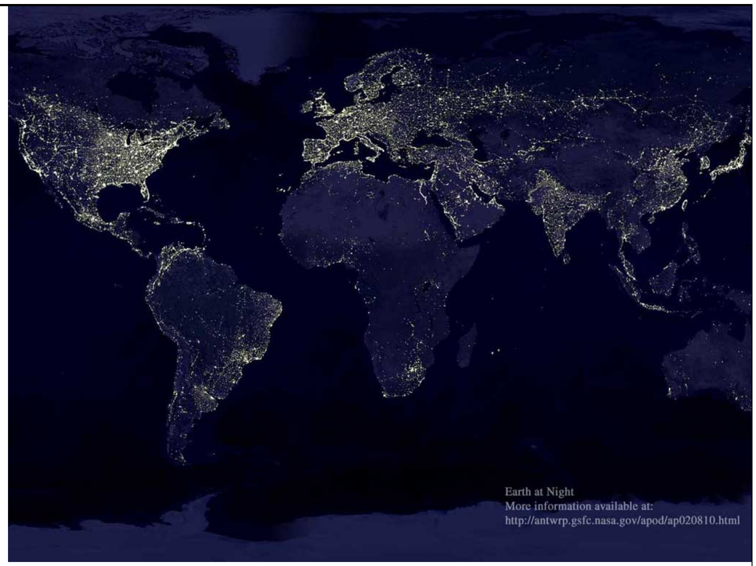
Many
Slides
Are
From
Prof.
Tom
Murphy
(with
Permission)
Thank
You
Prof.
Murphy



Physics 12: Energy and the Environment

Course Objectives

1. Become well informed on the topic of energy and its use in our society, so that you may participate in the national debate and make smart decisions
2. Understand the physical concept of energy and learn to identify it in the world around us
   – kinetic energy (energy of motion)
   – gravitational energy
   – chemical energy
   – thermal energy (a form of kinetic energy)
   – light (radiative) energy
   – nuclear energy

Course Objectives, continued

3. Address Energy Conservation
   - loss-less exchange of energy between forms
   - never created or destroyed—just converted/exchanged
   - expose my ignorance/limitations of PowerPoint
4. Learn to calculate energy content/conversion
   - most quantitative part of course
   - forms foundation for all that follows
   - applications to familiar everyday systems
   - math isn't hard, but units can be a pain

Course Objectives, continued

5. Learn about the energy usage in our lives
   - where we get it, where/how we use it, how we distribute it
   - some discussion of *why* we need so much energy
6. Discuss the (bleak?) future of energy production
   - fossil fuels can't last forever (or even very long)
   - alternative production of energy
7. Discuss the side-effects of energy production
   - environmental issues
   - sociological issues

Course Structure

- Class meeting times:
  - Lectures in York 2622: 2-2:50pm MWF
    - Homework due on Mondays
    - ABCD Card to promote interaction: bring to class every day; print from web site
    - Midterm: Mon May 9 (in class);
    - Final: Friday June 10, 3pm-6pm
  - Discussion section meets weekly (current day (Wed) may change to Friday
    - Opportunity for discussions on course material, exam prep, etc.
    - Math background and exercises
    - Work out example problems and questions

Resources

- Your Fellow Students!
  - Encouraged to work together on homework, exercises. However, copying anything is cheating and I take cheating seriously.
- Professor : Kim Griest

  Office in SERF building, Room 337, office hours M 11-12 PM, or by appointment, 858-534-8914, or drop in any time (call first to see if I am there!)
- Teaching Assistant: Joe Salamon: jsalamon@ucsd.edu

  Office hours TBA
- Web: physics.ucsd.edu and follow links to course web pages
- Text:
  - *Energy and the Environment*, 2nd edition Ristinen and Kraushaar

Grading

Weight	Format	Due	Comments
20%	Homework	Mon, in class	Graded 0-4, mostly on effort (& spot check)
up to 7%	Class Particip.	every lecture	via hand in questions
<30%*	Midterm*	May 9 (Mon)	
<50%*	Final*	June 10 (Fri)	

* Midterm and Final may count for as little as 23% or 43%, respectively, given extent of classroom participation and worst exam performance. Example: if you have 90% of the participation credit and bomb the final, the midterm still counts 30%, but the final will Counts 6.3% less, or 43.7% instead of 50%, the rest made up by participation credit

How Much Math !?

- The first part of the course is the most quantitative, but the math itself is straightforward
- That does not mean the ideas are trivial!
- We will be using
  - Simple graphs
  - Occasional basic algebra (rearranging equations a bit)
  - Averages
- Don’t let it psych you out when you see it…

Expectations

- Attend lectures and discussion section
- Participate!
  - If it doesn't make sense, **ask**! Everyone learns that way.
  - Don't be bashful about answering questions posed.
  - In-class voting system should make this fun
- Do the work:
  - It's the only way this stuff will really sink in
  - exams become easy
- Explore, think, ask, speculate, admire, <u>enjoy</u>!
  - Bring interesting topical ideas to class

Any Questions on Course Structure?

Question

What year are you?

- A. freshman
- B. sophomore
- C. junior
- D. Senior or more than 4 years
- E. None of the above

Course Preview: the Big Picture

- We use *a heck of a lot* of energy
  - primitive society uses < 100 W of power per person
  - our modern society burns 10,000 W per person
  - surely not in our homes! Where is this going on?
- Energy availability has enabled us to focus on higher-level issues as a society
  - art
  - science
  - home shopping network

- Long ago, almost all of our energy came from food (delivering muscle power), and almost all our energy went into securing food for ourselves
- Enter the work animal, supplementing our muscle power and enabling larger-scale agriculture
- Next burn wood to run boilers, trains
- 150 years ago, muscular effort and firewood provided *most* of our energy—and today this is less than 1% of the story
- Today, much more energy *goes into* growing/ harvesting food than *comes out of* food!
- Today in US 86% of our energy comes from fossil fuels (oil,natural gas, coal)

Fuzzy on the concept of energy?

- Don’t worry—we’ll cover that in great detail

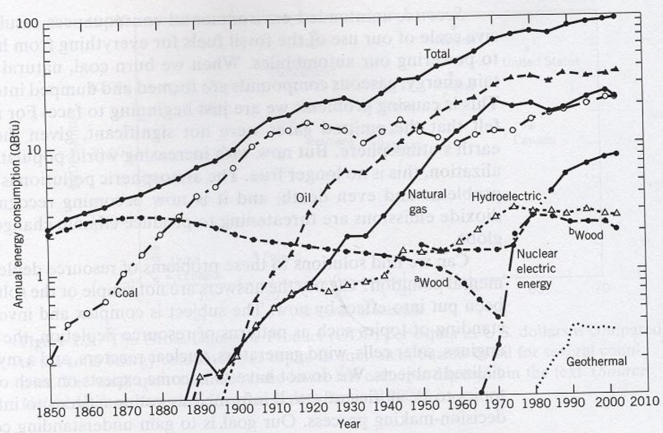
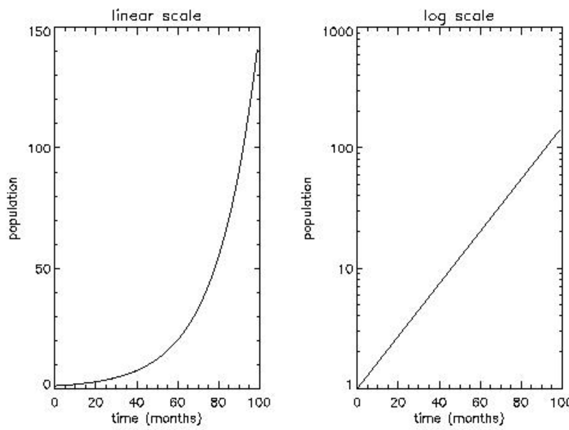


Figure 1.1 Various forms of energy consumed in the United States since 1850. This type of graph is called a semilogarithmic plot, an explanation of the scales is given in the Appendix. *Sources: Historical Statistics of the United States, Colonial Times to 1970*, U.S. Department of Commerce. Bureau of the Census, 1975; U.S. Energy Information Administration, *Annual Energy Review*, 2003. (a) The wood data set from 1850 to 1970 is from the first source. (b) The wood data set from 1950 to 2003 is from the second source; it includes wood, black liquor (a byproduct of the wood-based paper production process), and wood waste.

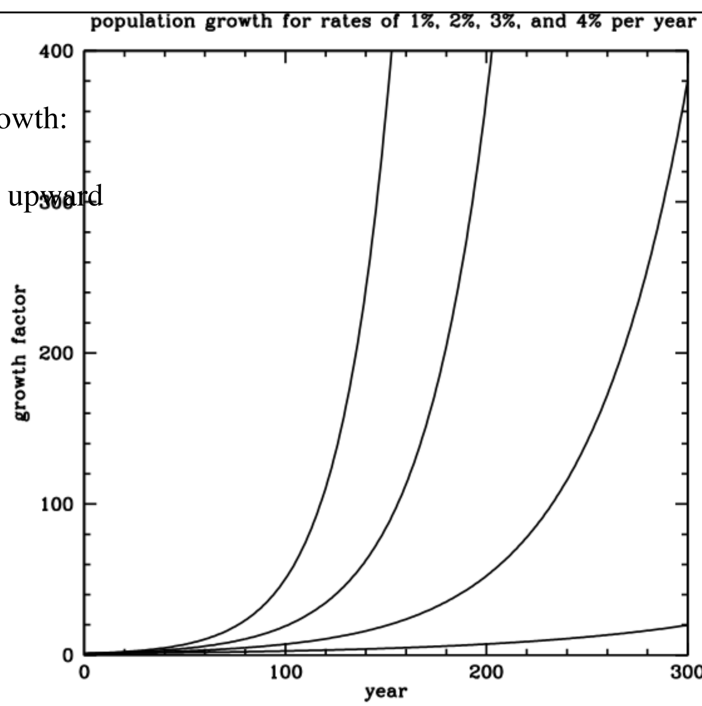
A note on graphs: log vs. linear

- Many graphs in the book are on logarithmic scales
- This condenses wide-ranging information into a compact area
- Pay attention, because you could warp your intuition if you don’t appreciate the scale
- Log scales work in *factors of ten*
- A given vertical span represents a constant ratio (e.g., factor of ten, factor of two, etc.)
- An *exponential increase* looks like a *straight line* on a logarithmic scale

Example Plots



Exponential plot is curved on linear scale, and straight on a logarithmic scale



Exponential growth:

If graph curves upward
Watch out!

Question

If a large piece of paper could be folded in half 44 times, how thick would it be?

- A. 1/2 inch
- B. 1/2 foot
- C. 1/2 mile
- D. 1/2 million miles

Why do we use so much energy?

This is classic exponential growth: since 1800's growth rates are between 0.5% to 1.5% per year

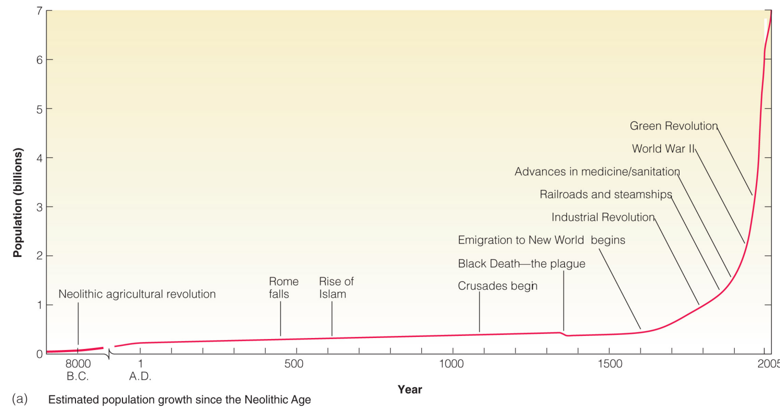
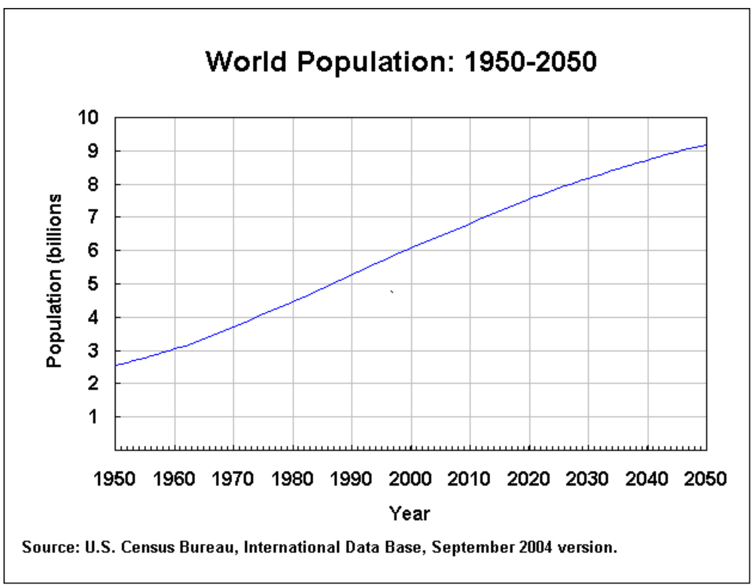


Figure 2-2a Estimated population growth in billions since the neolithic age.

Source: U.S. Census Bureau, International Programs Center, 2001.



Population History

- The total human population on the planet was small and increased slowly through most of human history. Maybe 1 million humans 125,000 years ago, growing only to 5-10 million by 10,000 years ago
- The population started to grow more rapidly due to human inventions: first agriculture, then industrial technology, and finally fertilizers and mechanized agriculture
  - 1000 BCE — 50 million (0.05 billion)
  - 0 CE — 0.15 billion
  - 1000 CE — 0.25 billion
  - 1500 CE — 0.5 billion (r < 0.1%: 8000BCE to 1650 CE: $t_{1/2}$=1000yr)
  - 1800 CE — 1 billion (r = 0.46%: 1650CE to 1800 CE: $t_{1/2}$=150yr)
  - 1930 CE — 2 billion (r = 0.54%: 1800CE to 1930 CE: $t_{1/2}$=130yr)
  - 1960 CE — 3 billion (r = 2%: 1960's and 70's: $t_{1/2}$=35yr)
  - 1974 CE — 4 billion
  - 1987 CE — 5 billion
  - 1999 CE — 6 billion
  - 2009 CE — 6.79 billion (r drops to 1.1%: 1970's to now)
  - 2010 CE — 6.9 billion

Population increase depends upon: number born – number dying.

Number born is related to TFR (total fertility rate) = average of number of children women bear:

TFR=2.1 will keep population constant. TFR>2.1 => exponential increase

To place this in perspective currently	Roughly equivalent to population of:
360,000 people born every day	Anaheim
150,000 people die every day	Oceanside
210,000 people added to the heap every day	Irvine

AND, if population continued to double every ~40 years (1%/year growth rate) …

2050– 10 billion
2100– 21 billion
2200– 46 billion
2300– 124 billion

Can human population continue to grow like this? ***Do we want this?***

How to calculate exponential increase

How many people in the year 2200 if pop increases at 1% per year?

Formula is $N=N_0x^n$

r=1% yearly increase for n=189 years (n=2200-2011=189)
r=.01; x=1+r = 1.01

Start with N_0=7 billion people today

Final answer is $N=N_0x^n$

N = (7 billion) $(1.01)^{189}$ =
(7 billion) (6.5) = 46 billion people

Participation Question

If Columbus invested $1 in 1492 and received 8% return per year, how much would it be worth today?

A. $519

B. $20,000 ($20k)

C. $2 million ($2M)

D. $2.2 Billion ($2G)

E. $200,000 Trillion ($2 x 10^{17})