Atoms and Stars
IST 2420

Class 1

Winter 2007

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Course web site: www.is.wayne.edu/drbowen/aasw07

Handouts

- Class 1 Notes
- IST 2420 Syllabus
- Lab 1 Handout
- Midterm Questions

Tonight's Schedule

- Logistics
- IST 2420
  - Syllabus
  - Characteristics of science
- Lab 1

Logistics

- Food & beverage machines
- Student Center is fairly close
- Bathrooms
- Water
- Take care of your own trash!
  - For labs, repack equipment where you found it.

IST 2420

- Meets WSU Gen Ed requirement for
  - Physical Science (PS)
  - Natural Sciences (PS and LS) laboratory requirement
- Initial the signin sheet
  - If you are not on the list, add your name at the bottom – this is NOT registration!!!
- Review of names

IST 2420 (main course)

1. Physical science content
   a. Nature of atmosphere
   b. Speed of light
   c. Solar system, Galaxy, Universe
   d. Early chemistry, atomic theory
2. Nature of physical science
   a. History and context
   b. Scientific method
   c. Experimentation
   d. Nature of scientific knowledge

IST 2420

- Review of syllabus
- Contact information
  - Proof that I don’t mind being contacted
- Textbooks and bookstore (Reader and Lab Manual are same as Fall 2006 only)
- Topics
- Grading scale (W, I)
- Weights
- Assignment schedule

Syllabus, continued

- Lab reports: two parts turned in as one
- Absence and Making up Work: labs, classes, exams
- Exam Questions and Essay Topics
- Essays
- Example of Mathematics Used In This Course
- Turning in assignments

Syllabus, continued

- Grade Appeals
- Educational Accessibility
- Assessment by the 4th Week
- Class Conduct
- Late/Missing Assignments
- Dropping Classes
- Grading for Course withdrawals
- Citations and Plagiarism

Assignments for next week

- Buy Reader / Lab Manual
- In Lab Manual, read General laboratory Instructions, Additional Laboratory Instructions and Experiments 1 and 2
- Report on Temperamental Can due
- In Reader, through Page 25
- Read Syllabus

How Do We Know What Science Is?

- Who says what the scientific method is?
  - We listen to what scientists say they do, and watch them doing it
    - For example, Huxley (1863) and Copi (1986).
      - Exception: Frances Bacon present “at the birth” ~ 1600
    - Science is an open community, but to be taken seriously, you must take its methods and concerns seriously
  - Galileo, Newton, Einstein and others were “mainstream” at first, revolutionary later
- No exact definition of science that everyone agrees to, so looking at examples is a good method

Definitions for Reading

- In “We Are All Scientists,” Huxley uses “induction” and “deduction” without defining them
  - Induction: reasoning from a series of identical cases to a general conclusion
    - In the reading, green apples example
  - Deduction: reasoning from different pieces of evidence to a conclusion in a specific case
    - In the reading, missing teapot and spoons example

Overview

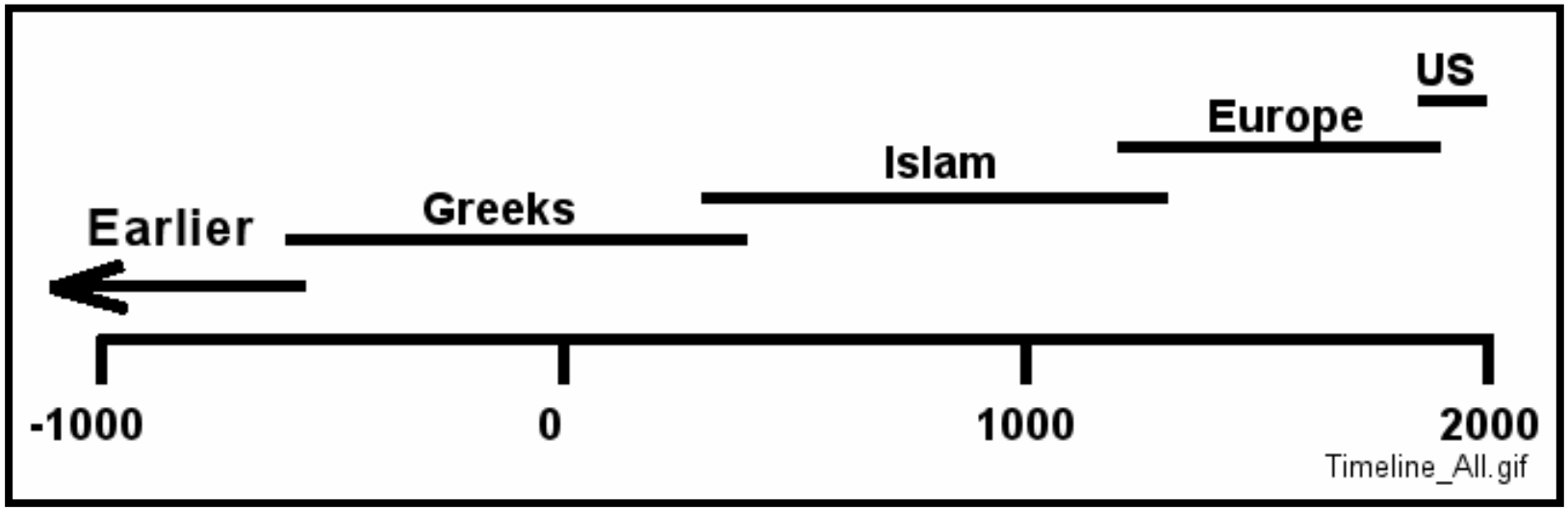
Scientific Method (as opposed to content):

- We will do more here than typical science course
- Here, Atoms and Stars is about origins of modern Physical Science (“science”) 1400 - 1800 AD in Europe
  - Development of Greek philosophy in the area of science, and how it was overthrown by science

Overview (cont'd)

- Scientific Method (cont'd):
- Modern Physical Science has roots going back to prehistory
  - It still represents something new
- Also part of the course – what happened:
  - Before the Greeks?
  - Between the Greeks and the development of science?
  - After the development?

Overview



- During development of science, much transmission by and (circa 1700) interaction with religion. Religion will come up.

Overview

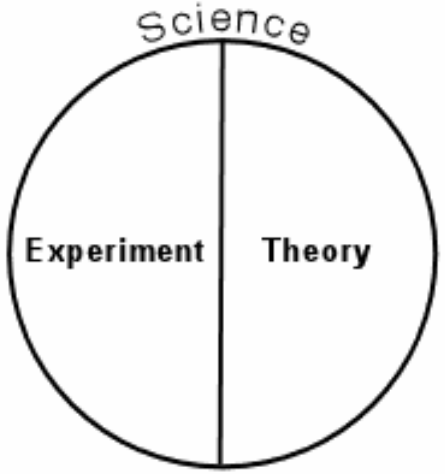
- My views (so you can evaluate what I say):
  - Scientist, advocate of science - secure and reliable information: brings understanding and supports action
  - At any time, science has limits, so it cannot be a complete basis for living: current shortcomings are human nature & interactions, place in world, purpose
    - Science skeptics be careful: science limits always expanding
  - Member of church (Quakers, or Society of Friends), have taught Sunday School, been clerk, secretary, given counsel within the church.
    - A liberal church, and I am liberal within that church.
  - Also a Ph.D. physicist (technical qualification)

Overview

- I make no claim to expertise in religion
- You have right here to your beliefs, to state those beliefs, to question, to reject science
  - Grading on your understanding of the course material, including the basis for trusting science
  - Science makes truth claims - what is the basis for believing those claims?
- I believe science and religion are compatible
  - Not all religious beliefs compatible with all science.
  - Once you reject some science, hard to stop
    - Science is interconnected

Overview

- Two pillars of science:
  - Data / observations / experiments
    - These make science reliable
  - Hypotheses / laws / theories
    - These make science valuable



Overview

- #1: Data / observations / experiments
  - Direct, not secondhand
  - Must be repeatable by anyone who cares to try
    - Often suggested by a hypotheses / law / theory, but must be repeatable even if you disagree
    - Anything important is repeated
    - Some things (speed of light) repeated for 100+ years
      - Improved technique triggers another round of measurements

Overview

- #1: Data / observations / experiments (cont'd)
  - o If data from different scientists disagree, discrepancy must be checked and resolved – not taken seriously until then
  - o Results cannot depend on beliefs or preferences – such effects must be checked and resolved

Overview

- #1: Data / observations / experiments (cont'd)
  - Must be recorded, not restricted or secret, with procedure (what you did, including preparation) and results (what you saw / measured)
    - So that others can repeat and verify your results
  - Journals and raw notes kept, will be reviewed if questions arise

Overview

- #2. Hypotheses / laws / theories
  - Hypothesis: first step - a guess, explain the data
  - Law is older term, theory is newer term (less assured)
  - Accepted theory must:
    - Be capable of being disproven (falsifiability)
    - Explain all (vast majority) data
      - Discrepancies must be addressed and eventually resolved

Overview

- #2. Hypotheses / laws / theories (cont'd)
  - Accepted theory must (continued):
    - Have direct evidence - not accepted just because rival theory fails
      - If two theories agree with data, must look for and do critical experiments that decide between them
      - If two theories covering different areas are inconsistent at their common points, this must be eventually be fixed
    - Be productive - predict new, unsuspected measurements, new phenomena, new results, which must be tested and which must agree
  - Simpler theory preferred to more complicated

Overview

- Typical sequence of advance (focus comes first and is assumed here):
  1. Observation / Measurement
  2. Description
  3. Understanding (theory)
     - Often this is first association (statistical) then causal
  4. Control or technology (especially last 50 years)
- Science is progressive
  - Start in small area, expand

Overview

- Science is progressive (cont'd)
  - Later theory / experiment can change earlier theory
    - Example: Einstein's 1915 General Theory of Relativity changed ideas about his 1905 Theory of Special Relativity
    - However, old results still correct but range extended
  - Scientific knowledge provisional – subject to change

Overview

- Science is progressive (cont'd)
  - Scientific knowledge can change rapidly at the frontier
    - Later experiments can show errors in the first ones
    - Extending theory beyond data can introduce errors
- Science is not:
  - Fair – theories do not have a right to be considered – someone must want to do this

Overview

- Science is not:
  - Democratic – no votes, no formal consensus, theories can come "back to life" (string theory)
  - Not based on authority – Newton and Einstein can be (were) wrong
- Most scientists follow these rules but (with many scientists) there are many exceptions
  - Science works socially – check each other

Overview

- Most scientists follow these rules but (with many scientists) there are many exceptions (continued)
  - Scientific arguments can be fierce
    - Issue about women and aggressive argument
    - Our heroes – the people who overthrew the established order
    - Instant success: prove someone else wrong
  - Scientists often become advocates of a theory
    - Social interaction corrects this

Overview

- Scientists are skeptical about truth claims
  - Many strongly-held beliefs have been shown to be wrong, e.g. common ideas about space
  - Many purely rational arguments have been shown to be wrong – e.g. Aristotle

Lab

- Form five Lab groups. Will be the same each lab session
  - If changes, max group size is six
- Temperamental Can – handout
- Each person keeps his/her data sheet
- Report will be individual, with an answer for each Assignment 1 – 12.
- Start heating water for Assignment 2 as soon as possible. This will take time to boil.

Lab

- Do not add ice to water until just before you are ready to immerse the can
- Practice this motion beforehand
- Discuss Assignment 1 before doing Assignment 2, and write individual answers.
- Then do rest of Assignments, come back to Assignment 2, 3 and 4 at the end.

Lab

- Reports should include (but it is one report):
  - Raw Data Sheet:
    - Setting: your name, experiment number, title and date, full names of lab partners
    - Procedure: what you did
    - Observations: what you saw happen and measurements during the lab period.
    - Hypotheses where requested, identified as hypotheses and separated from the rest
  - Typed analysis: Calculations and answers to questions in the lab manual
    - Do not retype Data Sheet – it would be less reliable

Questions or comments?

Lab session now