Atoms and Stars
IST 2420
and IST 1990

Class 2

Winter 2006

Instructor: David Bowen

Course web site: www.is.wayne.edu/drbowen/aasw06
IST 1990 Moodle: techtools.culma.wayne.edu/moodle

Handouts

- Class 2 Notes
- Midterm Questions, revised (Question 29 added)

Initial the signin sheet

IST 1990 photos

Due tonight

- Report for Lab 1. A lab report has two parts, turned in as a single assignment (stapled):
  - Data Sheet
  - Analysis
- Your hypothesis fails if the experiment is inconsistent
  - “Nature is the final arbiter” (judge) Q19
- Hypotheses and experimental improvements not easy or automatic – creativity needed

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

Overview

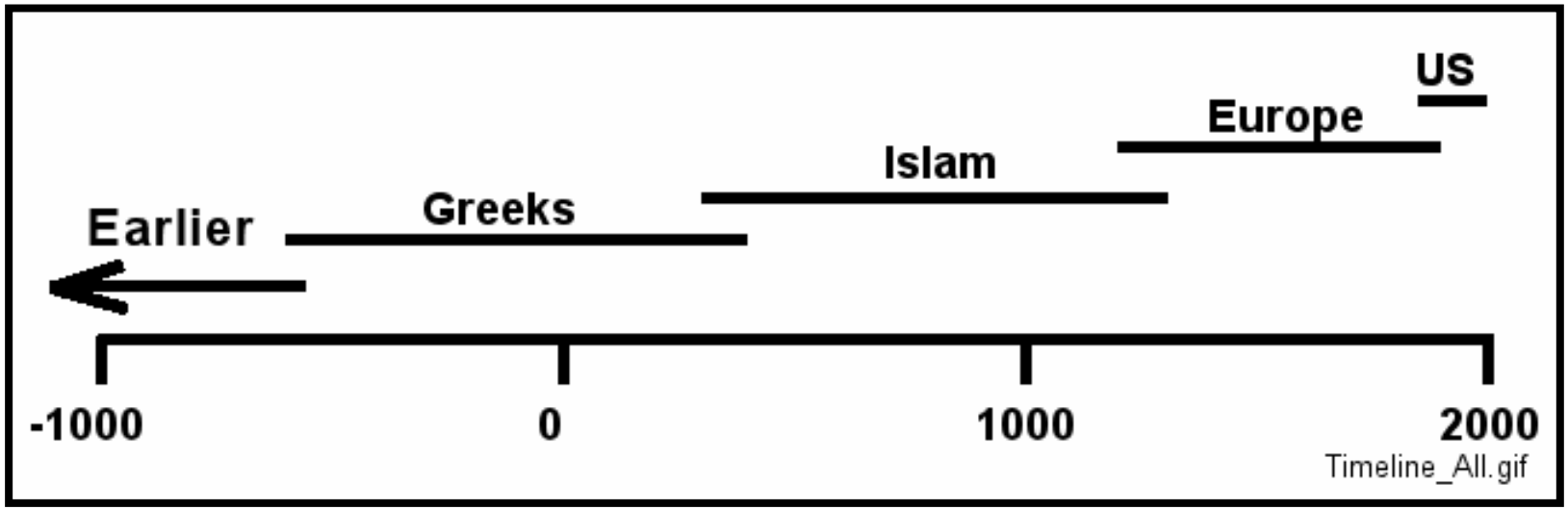
Scientific Method (as opposed to content):

- We will do more here than typical science course
- Here, Atoms and Stars is about origins of modern Physical Science (“science”) 1500 - 1700 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
  - Its development still represents something new
- Is this slow incremental change (roots) or a sudden change (development)?
  - Both ("tipping point")
  - Analogy – pile of sand in a dump truck

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 to support 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 - I am liberal within that church.
  - Also a Ph.D. physicist (technical qualification)

Overview

- 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.
  - But science is interconnected
    - Once you reject some science, hard to stop

Overview

- Two pillars of science Q27:
  - Data / observations / experiments
    - These make science reliable
  - Hypotheses / laws / theories
    - These make science valuable
    - Use in popular culture Vs. scientific usage Q29
      - In popular culture, “theory” usually means a passing thought, a possibility – “just a theory”
      - In science, a theory is an accepted and thoroughly tested explanation for a wide range of data – the top of the line

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
  - o Often data suggested by a theory, but data stand even if theory fails

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

Skip to 22?

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 are inconsistent, 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) Q28:
  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: Q20
  - 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, nor 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 individual exceptions

Overview

- Most scientists follow these rules but (with many scientists) there are many individual exceptions (continued)
  - Science is social – scientists help & check each other Q23
  - 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
  - Experiments keep science correct and reliable

Review of Essay Assignment

- Due February 8 (three weeks) on diskette
- Topic: We have studied the process by which an earlier theory is replaced by a later one: (a) Aristotle's view that nature abhors a vacuum was replaced by the sea of air hypothesis and (b) the caloric theory of heat was replaced by Rumford’s kinetic theory of heat. Following Copi's seven step account of the scientific method, explain how one of these transitions took place. Draw on material from the reading, class discussion, and the laboratory experiments. Also describe what this tells us about the scientific method.

Essay Assignment (cont'd)

- 3 to 4 pages, 12-point Times Roman, double-spaced, 1" margins top and bottom, 1½" left and right.
- Content: 40%. Reading and understanding course materials, applying them to topic, consistent point of view

Essay Assignment (cont'd)

- Form: 40%. Title page, Introduction (roadmap), Body (organized, transitions between topics, detail to support general points), Conclusion (review content, draws to an end)
- Mechanics: 20%. Spelling, grammar, punctuation. Use spell-check and grammar-check (note on passive) or dictionary.

Common Writing Problems

- Functional grammar
  - Rules of grammar have a purpose – to transmit meaning
  - Rules of grammar are always changing
  - Different grammars for different groups
  - Get too far from the group's grammar and you are not understood (must change with changes)
  - The further you get from the group's grammar, the harder it is to understand you
  - Being able to use good standard grammar is like dressing well for a job interview

#1 Reason for Writing

- To organize your own thinking

#1 Way to Good Writing

- Have something you want to say

More Examples and Details

- www.is.wayne.edu/olgt then link to Writing Guide, or The Everyday Writer
- Writing Center in 2310 UGL / 313-577-2544

Organization

- Many possibilities for organization
  - Historical
  - Logical
  - Specific to general, or general to specific
  - Combination
- Signal transitions from one topic to another
  - Paragraphs help here

Quick-and-Easy Organization

- Write body first
- One you have figured out what you are going to say (the Body), write the Introduction and Conclusion afterwards
- Body should have general statements and specific examples and quotes

Skip to 36?

Sentences

- A sentence:
  - Verb (action)
  - Subject (did the action)
  - Complete thought
  - (starts with capital, period at end)
- (Y/N) Because he hit the ball.
- (Y/N) John hit the ball.

Sentences

- Is it a sentence? Consider it all by itself.
- Common sentence problem #1:
  - Sentence fragment – something that starts with a capital and ends with a period but is not a sentence
    - Because he hit the ball. John ran to first base.
    - Fix by joining to main thought with a comma (,)
      - Because he hit the ball, John ran to first base.

Sentences

- Is it a sentence? Consider it all by itself.
- Common sentence problem #2:
  - Run-on sentence – two or more sentences written as one
    - John hit the ball he ran to first base.
    - Fix by breaking into two sentences
      - John hit the ball. He ran to first base.
    - Or by joining with semicolon (;) to show causality
      - John hit the ball; he ran to first base

Number (singular/plural)

- Both subject and verb have number
  - If these are not the same, signals conflict
    - Members join the club
    - A member joins the club
    - “One s”
- Without a reason, do not change number from sentence to sentence
  - (Bad) People should take care of their health. You should take your vitamins.

Tense (past, present, future)

- Without a reason, do not change tense from sentence to sentence

Citations

- “Scientific investigation is not, as many people seem to suppose, some kind of modern black art.” (Huxley, 1)
- Cite the source even if you are paraphrasing

Punctuation

- Apostrophe (‘)
  - Contraction
  - Possession (‘s or s’)
    - Some words inherently possessive, no ‘ (e.g. theirs)
  - Never for pluralization
- Lists
  - Separate list items with commas (last one is optional)
  - If any list has a comma inside, separate items with semicolon

Wrong Word

- Some words are commonly confused – memorize or use list or dictionary
  - o its Vs it’s
  - o whose Vs who’s
  - o their Vs there
  - o too Vs to
  - o accept Vs except
  - o Many, many more
- End of writing section, on to something else

Readings

- Huxley, “We Are All Scientists”
  - Induction. Apples, Math compared to Red Shift
  - Deduction. Teapot and spoons Q5
  - Must put a supposed theory or hypothesis to every test
    - (DB) Popper: science must be “falsifiable” – single failure can be doom to a theory
  - Hypothesis is normal
- DB: science prefers:
  - simple law before complicated one
  - universal law before specific

Readings (cont'd)

- Copi, "Science and Hypothesis"
  - Recent, long after the birth of modern science
  - Often uses Sherlock Holmes to illustrate
  - Seven steps
  - Science has
    - Practical benefit
    - Value in itself as knowledge
  - Scientists focus on a problem
    - Hypothesis to focus on pertinent facts
    - Used to gather more facts
    - "Aha" – serious hypothesis - creative

Readings (cont'd)

- Copi, "Science and Hypothesis"
  - Finding consequences of hypothesis
    - DB: If none, "not science"
  - Consequences must be tested
  - Application to problems
    - DB: Today, can lead to technology. Transistor, microchip, programmable computer, laser

Readings (cont'd)

- Copi, "Science and Hypothesis"
  - Example of caloric theory of heat to kinetic Q22
  - Caloric – a substance, add it to matter, temperature goes up
  - Count Rumford – worked on cannons
    - Boring generated very large amount of heat, could not believe you could mix in that much caloric
    - What could you add a lot of? Motion, led to…

Readings (cont'd)

- Copi, "Science and Hypothesis"
  - Kinetic theory of heat
  - Sir Humphrey Davy compared theories, devised test
    - Two pieces of ice, keep them frozen, rub together. Caloric could not get in
    - Did this, they melted, demonstrating kinetic theory
  - Later, Joule more tests, also measurements

Before the Greeks…

- Universe: about 15 billion years old
- Earth: about 5 billion years old
  - Molten at first
  - Cooled off, land formed about 4 BYA
- First life formed in seas about 3.7 BYA
- Earliest human-like animals (humanoids) evolved in southern Africa about 5 MYA

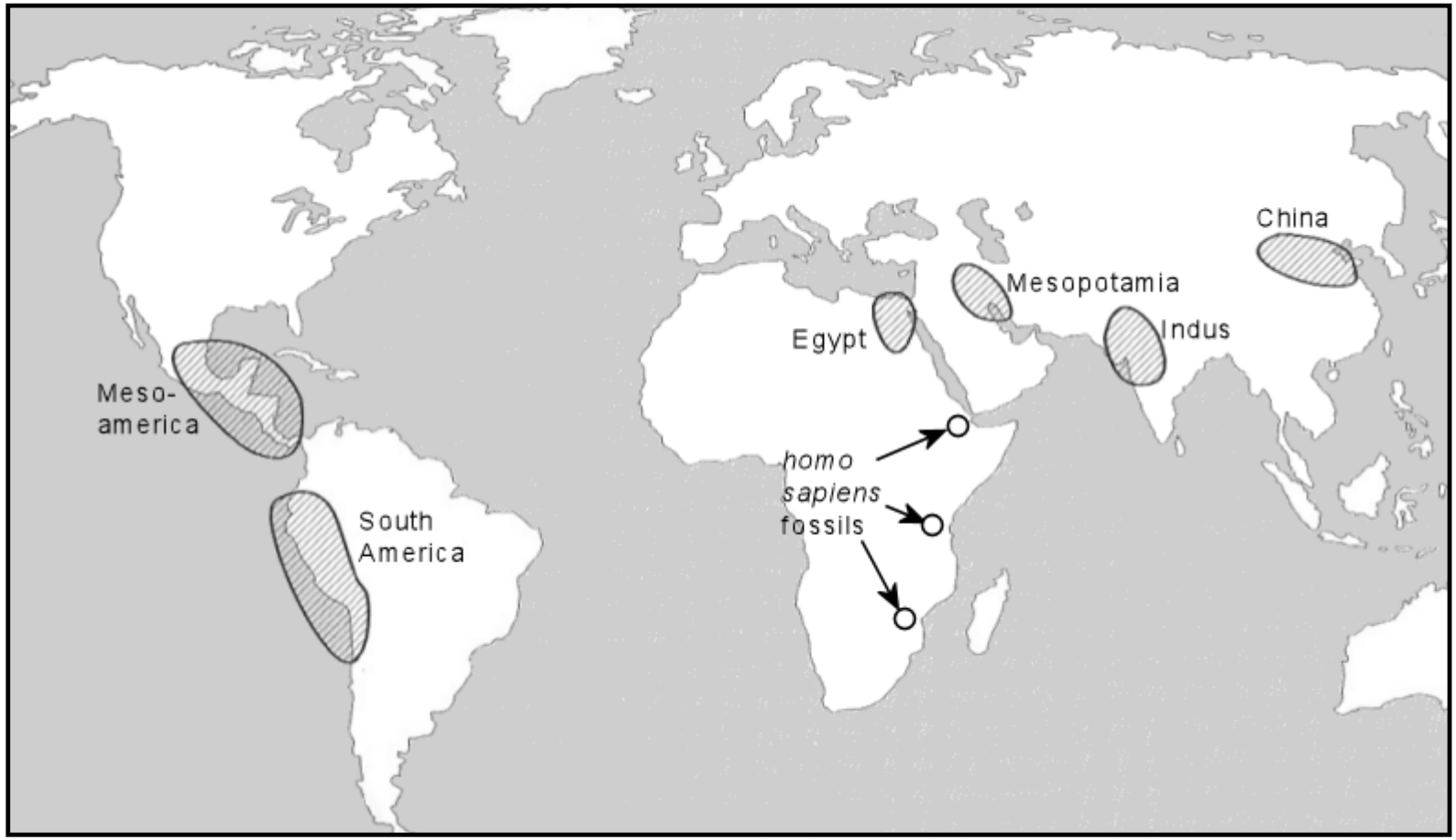
Before the Greeks…(Q21)

- McClellan and Dorn, Science and Technology in World History
- Jared Diamond, Guns, Germs and Steel
- Several humanoid species and expansions
- *Homo sapiens* (modern humans) evolved there
  - 100k to 400k years ago
  - Little genetic change since then
  - Expansions north, then East and West to Europe and Asia
  - Signs of early astronomy – phases of the moon

Before the Greeks (cont'd)…

- Early science developed with agriculture, large cities, complex and specialized societies
  - Areas shown on next slide (Diamond's thesis)
  - "Hydraulic civilizations" – irrigation or drainage
  - Large (monumental) building projects, e.g. pyramids (Egypt), canals
  - Highly efficient food production allowed cities
  - Strong central governments
  - American ones "incomplete" – no cattle, wheel, plow or (later) metal tools (but had metal jewelry)

Before the Greeks (cont'd)…



Before the Greeks (cont'd)…

- Some areas (Egypt) one nation, others (Mesopotamia) several (Sumer, Babylonia)
- Each lasted 1 – 2 thousand years
- Each developed empirical science (no theories – "recipes") in math, astronomy, geometry, medicine, but different strengths
  - E.g place-value numbers in Sumeria but not Egypt. Egypt had geometry for Nile flooding.
- Scientific theory (explanations) arose with Greeks

For next week…

- Lab Report for Experiment 2
- Reader: “Greeks Bearing Gifts”
- Manual: Experiment 3 Part 1

Questions or comments?

IST 1990 now

Lab 2 after

- Start water boiling first
- For hand vacuum pumps, record vacuum
  - Note two scales – record which one you use
- For “holed pop cap” seal joint with clay

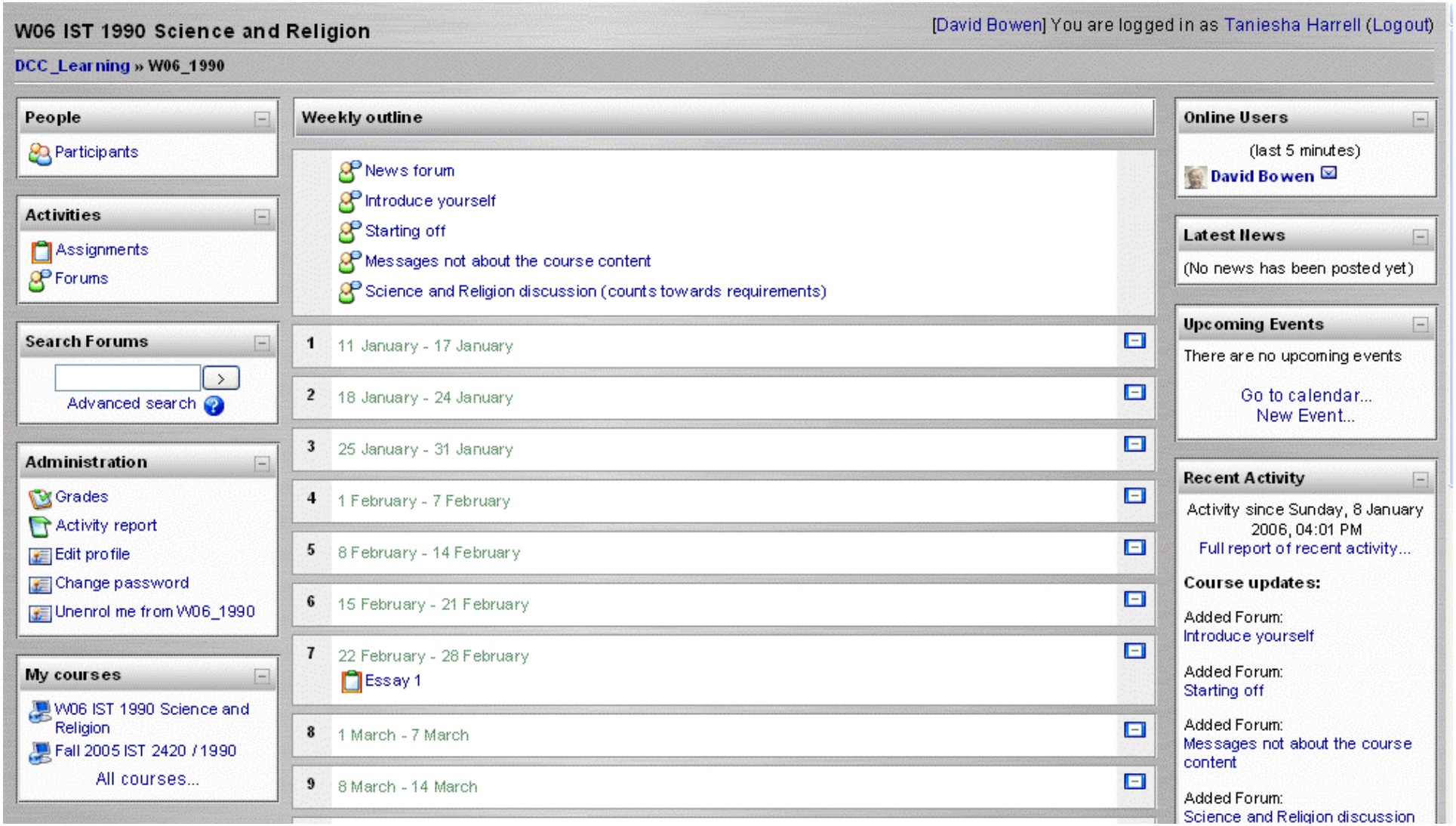
More on lab

Course Topic

- Science and religion - the interaction
- Free to hold your own religious beliefs, but course is about the range of ideas. Optional: where do yours fit in?
- Range of beliefs is very wide
  - Religion is superior
  - No conflict, some conflict
  - Science is superior

IST 1990

- The books
  - Gould: science and religion are, and should be, separate – they deal with separate areas
  - Barbour: what is the range of attitudes? Matrix
  - (four credits only) Ruse: How to reconcile Catholic doctrines with science
- See my notes on course web site
  - http://www.is.wayne.edu/drbowen/aasw06


W06 IST 1990 Science and Religion
[David Bowen] You are logged in as Taniesha Harrell (Logout)
DCC_Learning » W06_1990
People
Participants
Activities
Assignments
Forums
Search Forums
Advanced search
Administration
Grades
Activity report
Edit profile
Change password
Unenrol me from W06_1990
My courses
W06 IST 1990 Science and Religion
Fall 2005 IST 2420 / 1990
All courses...
Weekly outline
News forum
Introduce yourself
Starting off
Messages not about the course content
Science and Religion discussion (counts towards requirements)
1 11 January - 17 January
2 18 January - 24 January
3 25 January - 31 January
4 1 February - 7 February
5 8 February - 14 February
6 15 February - 21 February
7 22 February - 28 February
Essay 1
8 1 March - 7 March
9 8 March - 14 March
Online Users
(last 5 minutes)
David Bowen
Latest News
(No news has been posted yet)
Upcoming Events
There are no upcoming events
Go to calendar...
New Event...
Recent Activity
Activity since Sunday, 8 January 2006, 04:01 PM
Full report of recent activity...
Course updates:
Added Forum:
Introduce yourself
Added Forum:
Starting off
Added Forum:
Messages not about the course content
Added Forum:
Science and Religion discussion

Moodle

- Do not expect instantaneous responses from me
- You do not need to respond to everything – gets out of hand if you do
  - o I usually do not respond to messages that I agree with
  - o I always respond to messages that I disagree with
  - o Responses as well as original messages count

1990 To Do…

- Create Moodle account
- Reading schedule in Syllabus
- Postings averages
  - 2 credits: one per week
  - 4 credits: two per week
- Look at web site (www.is.wayne.edu/drbowen/aasw05)
  - Essay questions
  - My comments on the books

Questions or comments?

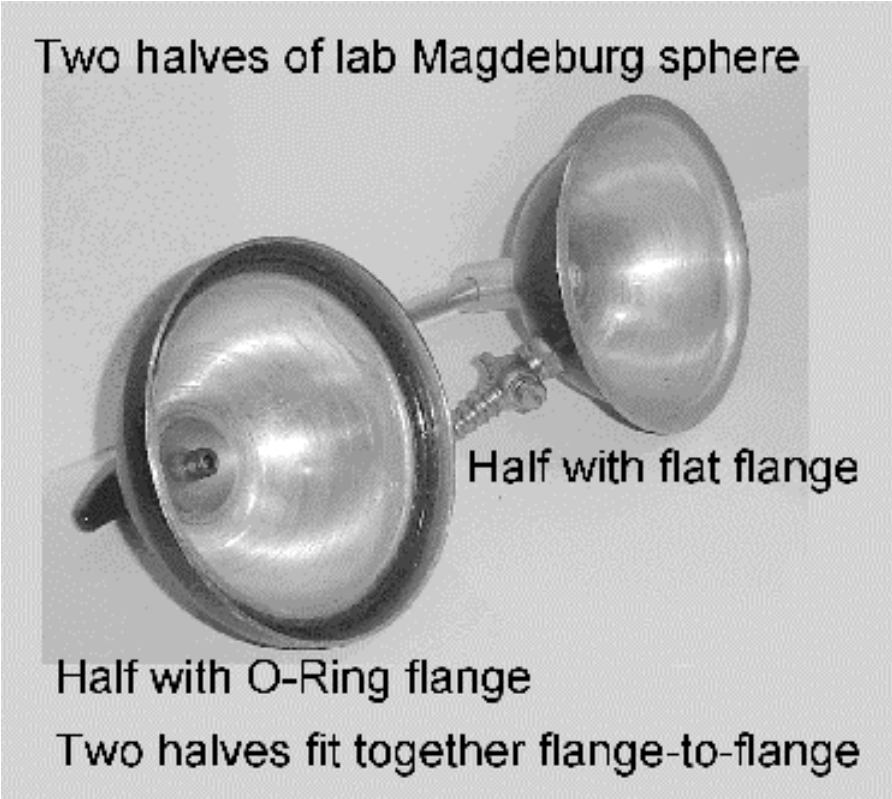
Lab 2

Lab 2 Theory

- Scientific Revolution 1500 – 1700 AD
- Before, prevailing view about air pressure due to Greek philosopher Aristotle 384 – 322 B.C.
  - o "Nature abhors (hates) a vacuum – will not let it exist, other matter rushes in
- Replaced by "sea of air" due to Torricelli
- Observation of a vacuum for water columns higher than 34 feet in a tube closed at the top – practical limit on suction pumps

Lab 2 (cont'd)

- Vacuum seal is O-ring, Vaseline and flat flange
- Valve is open when handle is in-line, closed when handle is "crossed" – look down the valve!



Back to notes