

Atoms and Stars IST 2420 and IST 1990

Class 11

Winter 2006

Instructor: David Bowen

Course web site: www.is.wayne.edu/drbowen/aasw06

IST 1990 Moodle: techtools.culma.wayne.edu/moodle

Agenda

- Assignments and passbacks
- Pick up:
 - All: these Notes for Class 11
 - IST 1990 only, from me: Summaries of books
- Upcoming assignments
- Miscellaneous
- Readings: Atomic Nature of Matter
- Physical Science and Natural Disasters
- Life Science: “Bird Flu” – current science
- Lab 9: Archimedes’ Exploits (cont’d)

Stuff

- Remember to initial the sign-in sheet
- In your lab report, don't write that you followed the procedure in the lab manual, if there is no lab procedure for that part (for example, if that part is only a calculation).

Changes in Lab Schedule

- Last week, I extended Lab 9 over two weeks
- No lab report due this week; turn in a single report for both weeks on April 5
- See remarks on first part of Lab 9 later tonight
- Changes to Syllabus lab schedule:
 - Lab 7 on April 5
 - Lab 11 on April 12
 - We will not do Lab 4 (we will go over the content)

Upcoming ...

- Next week:
 - Reader: Chemistry
 - Manual: Lab 7
 - Due: Report for Lab 9
- April 12: SET
- April 19 (last regular class)
 - Essay 2 due
 - Review for Final Exam
- April 26: nothing that night but the Final Exam

IST 1990 (Directed Study)

- Reminder – course is about the RANGE of approaches to the topic “Science and Religion”
 - Can give your own approach as part of RANGE
- Essay 2 due (4 credits)
- Reading (4 credits): Finished Rocks of Ages and Can a Darwinian be a Christian?, starting When Science Meets Religion
- About 20 postings on Moodle by now

Grade What-If

- Grade What-If (on course web site – see first slide for this URL)
 - One complaint that it was not working
 - I tried this, and it is working
 - Reminder: to get current course average, do NOT put anything in for assignments you haven't been graded for yet
 - If you put anything in, remove it using “delete” key
 - To see what happens if you miss assignments, put in zeroes for those (this is what I will do)

Writing

- “lens” not “lense”
 - Plural is “lenses”
- For cart in case where wheels not covered with tape, this is “untaped” rather than “untapped.”
- For help on writing:
 - www.is.wayne.edu/olgt
 - Writing Center 2310 UGL 313-577-2544
 - Have something you want to say, then organize

Semester is Ending!

- If you have been relying on being able to turn work in late, *it is time to get going*
 - Alternatives: D, E, I, X, drop – see counselor!
- Getting ready for Final:
 - Read Information Sheet carefully – a lot of information there
 - Look at Final Topics carefully
 - Use Review Session!
 - Final Where-Is probably April 12

Two parts

- Newton ended the “Stars” part of this course
- This week start the “Atoms” part
- “Element” – Greeks understood this to be something fundamental, without parts, not made from other things
 - Aristotle: air, earth, fire & water are elements
 - First discoverers of atoms disproved Aristotle, thought atoms were the Greek elements
 - Today we still call atoms “elements,” but not in the same sense – they are made of other things
 - Still have question of what (if anything) is elemental

And now...

- “Atoms”
- Before Einstein & $E = mc^2$, matter and energy separate
- Atomic Theory – all matter is made up of atoms
- Start by looking at our knowledge of atoms
- Then, how did this knowledge come about?

Readings

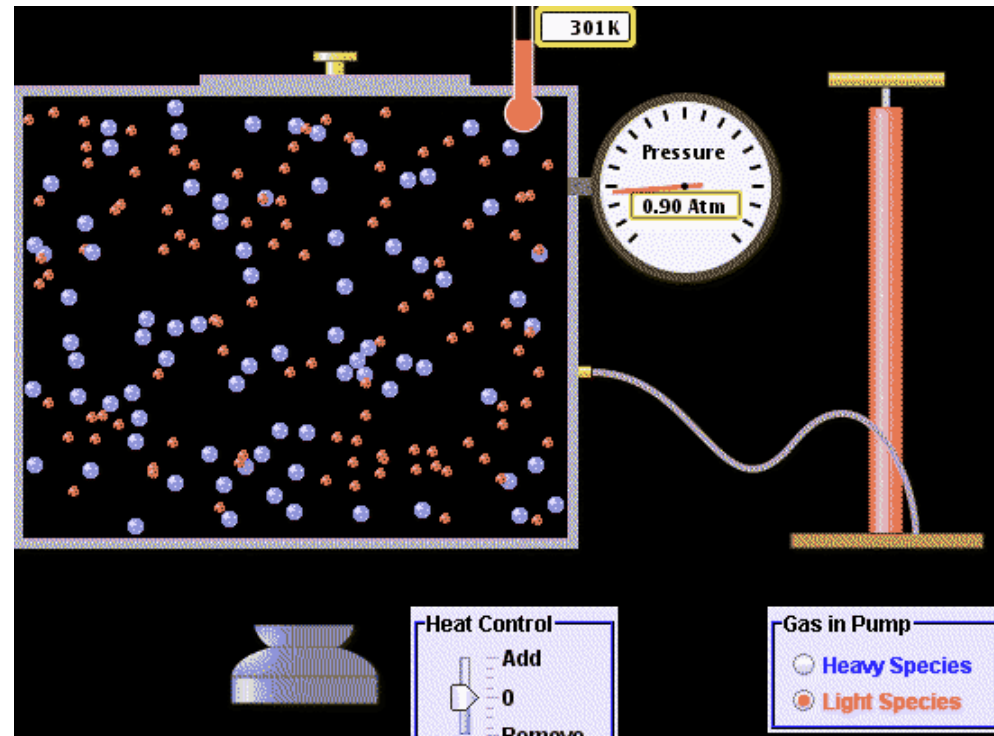
“Atomic Nature of Matter”, Hewitt

- All matter is atoms (“Atomic Theory”)
 - Atoms are elements – “indivisible” – mostly empty (10c#1)
 - 109 types total, 90 are natural, rest radioactive
 - Each type has its own properties, e.g. weight, reactions
 - Hydrogen most common atom in universe
 - Rare by itself on earth
 - Life primarily C, H, O, N
- Atoms small enough to be invisible - waves

Atomic Nature of Matter

- First direct evidence 1827 Robert Brown (10c#2)
 - Noticed spores jiggling under microscope
 - “Brownian motion” – bombarded by molecules
 - See next slide, or
<http://www.colorado.edu/physics/phet/web-pages/simulations-base.html>
 - Now we have more direct evidence
- Atoms bond into molecules – many types (10c#1)
 - Molecules - compounds
 - Molecules have separate properties from atoms
 - Burning is combination with O
 - New - modern automobiles very little CO

Brownian Motion



Imagine the red molecules were so small that we couldn't see them – blue ones would “jostle” for no apparent reason.

Atomic Nature of Matter

- 1811 (Amedeo) Avogadro's hypothesis (now Law)
 - At same T & P, equal Vs of gas have equal #s
 - Each atom, molecule heavier → gas heavier
 - Amu = atomic mass unit
 - C ≡ 12 amu, H ≈ 1 amu, O ≈ 16 amu, U ≈ 238 amu, H₂O ≈ 18 amu – also combine in gm, lb etc.
- Atom has electrons orbiting nucleus
 - Electrons – volume but very little mass
 - Nucleus – mass but very little volume

Atomic Nature of Matter

- Electron, e – negative charge, flow of electrons is electrical current
- Nucleus has neutrons, n (no charge) and protons, p (positive charge)
 - Cube 3/8” would weigh 133,000,000 tons
- Like charges repel, unlike charges attract
 - Nucleii positive, repel each other
 - Atoms neutral; #e = #p
 - #e not = #p under special circumstances

Atomic Nature of Matter (end)

- Electrons in shells (2, 8, 18, ...)
 - If shells filled, element is inert
 - Unfilled shells determine activity
 - #p = atomic number, chemical characteristics
 - Same element even if atom loses or gains electrons
- Antimatter – anti-electron (1932), anti-neutron, anti-proton
 - Annihilate → 100% energy (light)
 - Nuclear reactions normally 1%
- End of article...

Element, Compound, Mixture

(10 a-b)

- Element: matter with all atoms the same
 - Examples: C, S, H, O
- Compound: made up of the same molecules
 - Examples: H₂O, CO₂
 - Matter with all molecules the same
 - Atoms bond together into chemical combination
 - Always the same composition

Element, Compound, Mixture (end)

- Mixture
 - Atoms and molecules not close enough to bond
 - Composition varies
 - Examples:
 - Air (mostly N and O) but variable
 - Amount of greenhouse gases an issue – CO₂
 - Earth – composition extremely variable
 - Add various fertilizers
 - Dough – vary composition for different breads
 - Cinnamon and sugar
 - Constituents could in principle be separated

Epistemology

- Several times you have asked me “Is this absolutely true?” I tend to hesitate with questions like this – here is why.
- Epistemology – the study of knowledge – why do we accept things as true?
- Two properties we would like for truth:
 - Eternal – unchanging
 - Universal – the same everywhere

Epistemology (end)

- Science doesn't do “eternal”
 - Scientific truth is provisional – subject to change
 - We keep learning new things and improving theories
- Religions have problems with “universal”
 - Each religion claims universality but how can different religions differ, if there is one truth?
 - For science and religion, Galileo agreed with modern Catholic doctrine – there is one truth
 - Reinterpret Bible if it disagrees with accepted science

Natural Disasters #1

- Hurricanes, tornadoes, earthquakes, tsunamis, mudslides
- Hurricanes best understood
 - Rising air over warm ocean – spirals counterclockwise as seen from above in Northern Hemisphere due to earth's rotation
 - Picks up water vapor, condenses out higher up

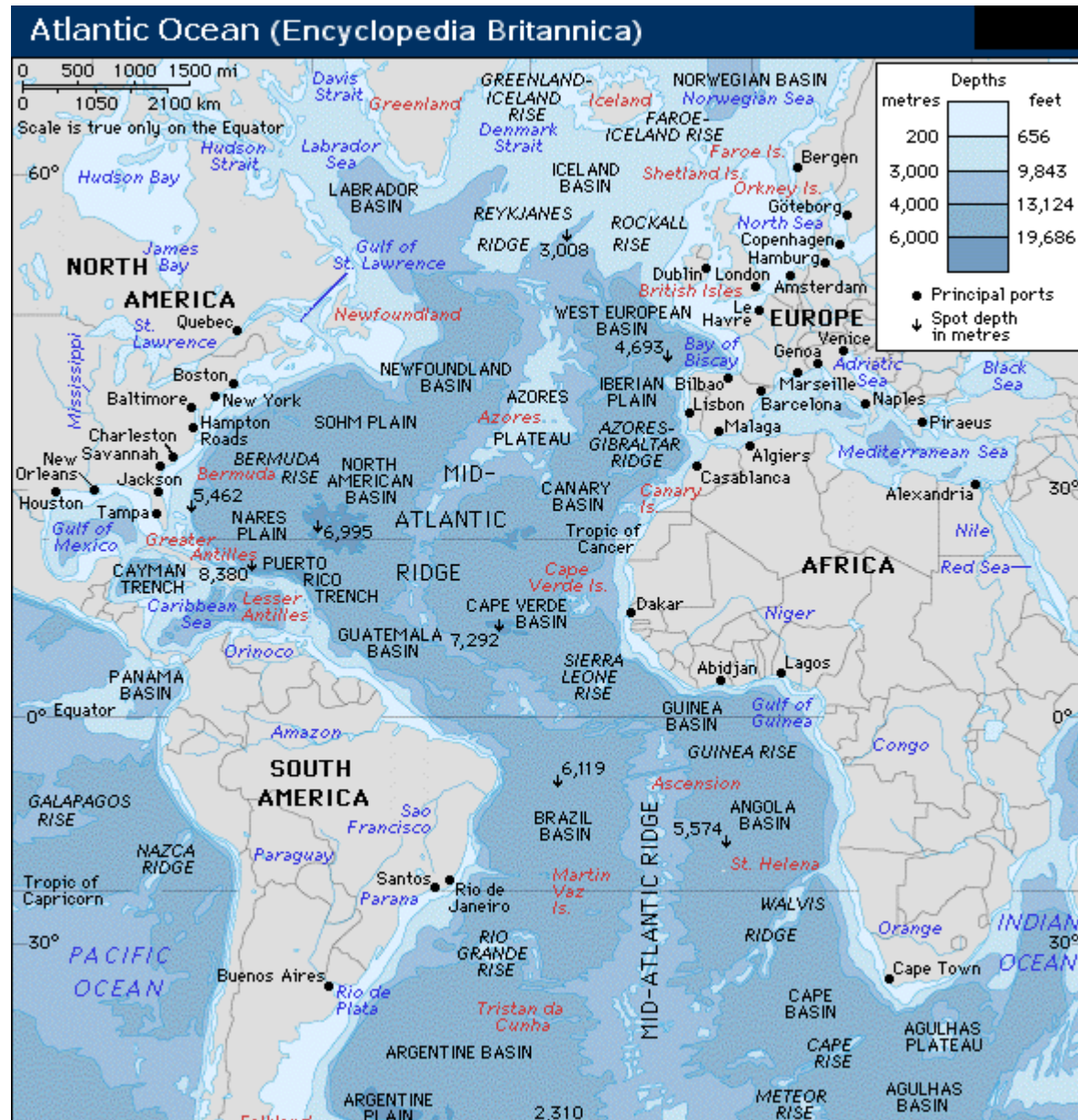
Done previously

Natural Disasters #3

- Earthquakes
 - o “Plate Tectonics” gives general explanation
 - o Earth molten when formed ~ 4.5 BYA
 - o Cooled, surface condensed into continents (thin “plates”) floating on molten core (“magma”)
 - o Currents in core, like currents in boiling water, carry plates, like the skin on cooking pudding
 - o Plates crash into each other → earthquakes

Example:
 North & South
 America were
 joined to
 Europe and
 Africa, magma
 is boiling up at
 Mid-Atlantic
 Ridge, pushing
 them apart.

Geography and
 species from
 before split
 match across
 Atlantic ocean



Natural Disasters #5

- Earthquakes
 - As plates crash, tension in “crust” builds up
 - Longer time between quakes → larger quake
 - Cannot presently tell when quake will happen
- Tsunami – wave formed from underwater earthquake
 - Sensors, warning system, disaster network can move population out – Hawaii and Alaska monitoring centers
 - No such system in Asian 2004 tsunami, being built now

Natural Disasters #6

- Mudslides
 - o Deforestation and development mean vegetation on hillsides being cut back
 - o People living in these areas due to growth in population
 - o Heavy rains weaken hillside
 - o Depth of slide can be hundreds of feet or more
 - o Can be foreseen, but weak societies cannot act

Natural Disasters #7 (end)

- Natural Disasters
 - o At present, we cannot predict or control these
 - o We are learning a lot about them
 - Earthquake and hurricane construction codes
 - Modern buildings in California much better against quakes, in Florida against hurricanes
 - o Prediction will come first, control is a maybe

Current Issue: Bird Flu

- Spread of Avian Flu strain H5N1(A)
 - Many infectious diseases cross from animals to humans in poor regions where animals and humans live together
 - Biggest problem would be evolution or mutation from (animal-infects-human) strain to (human-infects-human) – this is what scares the experts
 - New virus, no immunity , serious, spreads quickly
 - H5N1(A) from Asia, still (bird-infects-human)
 - If more humans exposed, more chance to evolve

Bird Flu (cont'd)

- (Bird-to-human) path is slow, not the big concern
- H5N1(A) spreading faster among birds than anticipated
 - Asian commerce not understood
 - Governments slow to prevent, react
 - Now being spread by wild bird migrations
 - Spread to domestic flocks via falling fecal matter
 - Perhaps in US by August
 - Infected poultry that is well cooked is safe to eat
 - Not generally known, devastates local poultry industries (France)
 - Now infecting other animal species
 - More possible paths to human-to-human infection

Bird Flu (cont'd)

- Two possible paths to cross from animal-to-human to human-to-human
 1. Direct
 - Historically most devastating – 1918 flu epidemic
 2. Combination with human virus
 - We have some exposure and immunity, has been milder
- Two approaches to protection:
 1. Slow the spread of infected birds – not working as well as hoped – see above
 2. Prepare for treatment of humans

Bird Flu (cont'd)

- Treating humans
 - o No specific vaccine yet
 - Tamiflu is generic
 - Vaccines currently slow to produce, so stockpile them
 - Hoarding?
 - Virus will further evolve (mutate) so vaccines become less effective over time, stockpiling may not work well
 - o Stockpiling ventilators – expensive, lagging
 - o Training first responders and medical personnel (public?)
 - Collect and track spread
 - o Quarantine laws, regulations and practices
 - Happening in US and Western countries

Bird Flu (cont'd)

- May take a long time to evolve into human-to-human
 - Just last week: strikes deep in human lungs, evolution path is longer than previously thought, chance smaller
 - May not be a virulent strain when it happens
 - Hard to maintain vigilance and effort
 - May never evolve into human-to-human
- If (when?) becomes human-to-human, with global culture, can travel very fast
 - Are people infectious without yet having symptoms?
This would be much worse
 - AIDS can be spread before symptoms appear
 - Not known yet for this

Bird Flu (cont'd)

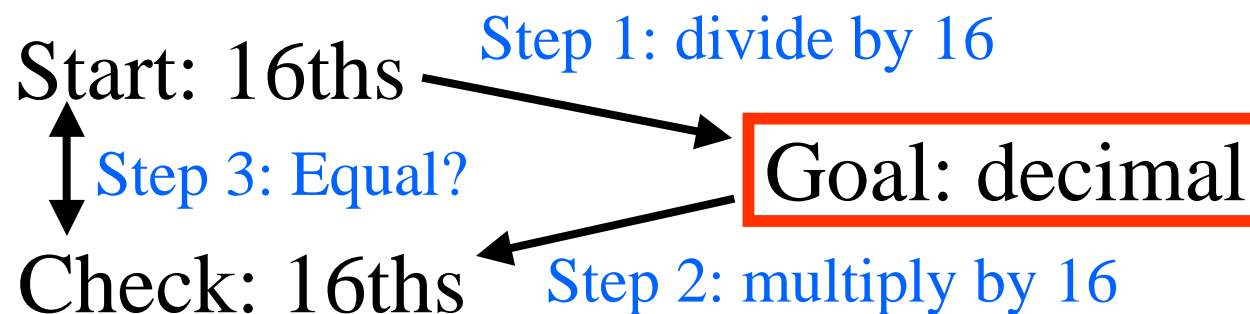
- UN genetic database for H5N1(A)
 - Currently limited-access so investigators can still publish papers while putting in latest info
 - One Italian woman scientist says it should all be public, putting her results on the web
 - Issue of scientific communication
- What is the final story for Avian Flu? We don't know.

Bird Flu (end)

- A small chance of a large disaster
 - Humans have not dealt well with this type of situation
- Science is far from complete
 - Major parts unknown
 - Chance of evolution to (human-to-human)
 - Seriousness if this happens – spread, lethality
 - Ability to develop and manufacture vaccines
 - The boundary of scientific knowledge very clear – experts disagree on seriousness
 - Some say very serious crisis, others say a minor concern

Experiment 9: last week

- Measure curved shapes by winding string around shape, measuring string
- Converting 16ths to decimal & the check:



- The Goal is the tenths!!!

Experiment 9: last week

- $C = \pi d$ and value of π can be proven in Plane Geometry (Euclid)
- Lab 9: measuring C and d to check formula and value of π
 - Archimedes did something similar with volumes of geometric shapes (cone, pyramid, cube) – measure instead of formula
- All groups found agreement between formula and measurement within .1” or .2”

Experiment 9: overall

- Important conclusions from last week:
 - The formula is almost certainly correct
 - Value of π almost certainly correct
 - The method for measuring C is valid within .1” or .2”
 - Method: putting pins along path, looping string along pins, removing string and measuring its length
- Circle part and ellipse part are connected. DO NOT treat them as separate.
- Should measurement errors be the same, or different?