Review for ASTR/ATOC 3720 Final Exam Spring 2003

Exam Time and Place: Wednesday, May 7, 2003, 1:30-4:30pm, room G131 Duane

Scope: The final is cumulative, covering all material from the entire semester, including lectures, readings, homeworks, quizzes, handouts, discussions, and flights of fancy you had while sleeping on your textbooks.

Format: No books or notes are allowed during the final. You may use a calculator, a pencil, and your brain. The final will consist of three parts: True/False questions, Multiple Choice questions, and Short Answer questions. As with the quizzes, you will be given a formula sheet with all the equations you need (plus some extras). You will have to know which equations to use and how and where to use them, as the formula sheet will not label the equations.

Worth: The final exam is worth 30% of your course grade. (The rest of your course grade will be weighted as 20% for each of the two quizzes, 20% for your homeworks, and 10% for class participation.)

Grades: Your course grades will be posted on the class webpage as soon as possible after they have been determined (http://lasp.colorado.edu/~eparvier/astr3720). It would behoove you to go to the grades webpage and check that all the grades I have listed for you are correct. If you have a dispute, contact me and bring proof of the correct grade along with you to office hours or to the final exam.

Office Hours Before Final: I will be in room D230 Duane from 2:30-5pm on Monday, May 5, and Tuesday, May 6. If you wish to arrange another time to discuss the final contact me at 303-492-4546 or eparvier@colorado.edu.

How to Study for an Eparvier Final Exam:

- Read through your notes. If anything seems confusing, consult my notes on the website. If you have time, read through both your notes and my notes.
- Skim through all of the readings. (You should have read thoroughly Goody and Walker chapters 1, 2, 3, and 4. You also should have read thoroughly the New Solar System chapters 1, 2, 13, 15, 20, 21, 27, and 28 and skimmed lightly through chapters 8, 9, 11, 12, 14, 17, 18, and 19.)
- Look at the homeworks and quizzes and their solutions on the website, paying special attention to my solutions for problems you had difficulty with.
- Make sure you understand how to do all the calculations we’ve done in class and when and where they can be used (or not used).
- While you do all of the above, do not get hung up on numbers and minor details. Instead, think about what themes are tying the entire class together and how concepts you learned while studying one part of the solar system apply to other parts of the solar system. Look at the similarities and differences in the solar system and think about why things are similar or why they are different.
- Come to the office hours and talk to me about anything that confuses you.
My goodness, you’ve learned a lot! Topics you should be familiar with (from previous reviews plus some new stuff learned since the last quiz).

- General characteristics of the planets
- “Story” of the formation of the solar system
- Calculating “equilibrium” or “effective” temperature
- Ideal gas law: temperature, pressure, number density
- Hydrostatic equilibrium
- Barometric equation
- Scale height
- Adiabatic lapse rate: specific heats and gravity

- Atmospheric structure
  - By composition: homosphere, heterosphere, diffusive separation
  - By temperature: troposphere, stratosphere, mesosphere, thermosphere
  - By ionization: ionosphere

- Light interacting with matter
  - Scattering, absorption, ionization, dissociation, …
  - Lambert-Beer Law: optical depth, cross sections
  - The solar spectrum
  - Chapman profile
  - Kirchoff’s Laws of Radiation:
    - High pressure gas (or liquid or solid) when heated
      - Wien’s Law, Stefan-Boltzmann Law
    - Low pressure gas at high temperatures
      - Emission spectrum
    - Low pressure gas at low temperatures
      - Absorption spectrum
  - Spectroscopy as diagnostic of composition, concentration, temperature, relative motion

- Energy Budget of Earth:
  - Roles of the atmosphere in energy balance
  - Greenhouse effect
  - Enhanced greenhouse effect
  - Ozone and ozone changes

- Radiative transfer and the “Slab” or “Two-stream” model
  - $T_e$ and $T_g$
  - Optical depth
  - Column density

- Global Circulation in atmospheres
  - Hadley cells
  - Coriolis effect
  - Easterlies, westerlies, highs and lows
  - Pressure forces and highs and lows
    - On small scales
    - On large scales (coriolis effect)
  - Geostrophic wind
  - Planetary scale waves
• Venus in the present:
  o Basic properties of the planet and its surface
  o Atmospheric composition, temperature, etc.
  o Cloud layer
  o Surface motion of atmosphere
  o Superrotation of atmosphere at cloudtops
  o Greenhouse effect
• Venus in the past:
  o Runaway greenhouse effect
  o Role of water on Earth and Venus
  o Generic sources of atmospheric gases: planetary nebula, release during accretion, outgassing, later arrival via icy bodies, sublimation from surface, sputtering/micrometeorite impacts
  o Generic sinks of atmospheric gases: Thermal (Jean’s) escape, hydrodynamic escape, non-thermal heating, sputtering/impact erosion, solar wind pickup, transport to other reservoirs
  o Maxwellian distributions, most probable speed, escape speed
  o Limiting rates
  o Saturation vapor pressure vs temp curves
  o D/H ratios and what they mean for water on Venus
• Some Earth topics:
  o Everything you know about Earth from the first part of the course
  o Chinooks, lee-waves, upslopes
  o Role of water in the present Earth atmosphere
  o Role of water in the early days of Earth’s atmosphere
• Mars in the present:
  o Basic properties of the planet and its surface
  o Atmospheric composition, temperature, etc.
  o Martian polar caps, composition and cycles
  o Water cycle on Mars
  o \(\text{CO}_2\) cycle on Mars and surface pressure changes
  o Seasons and the orbit of Mars
  o Dust storms on Mars
• Mars in the past:
  o Evidence for ancient climate change
  o Evidence for recent climate change
  o Timeline of Mars history
  o Where’s the water? Where’s the \(\text{CO}_2\)?
• Jupiter and Saturn:
  o Bulk compositions and internal structures
  o Internal heat sources and their effects on the atmospheres
  o Temperature profiles and cloud layers
  o Belts and zones
  o Storms, the Great Red Spot, lightning
  o Magnetic fields, magnetospheres, and aurora, including sources of particles for aurora, and causes of magnetospheric storms
• Uranus and Neptune:
  o Bulk compositions and internal structures
  o Obliquity of Uranus and its effects
  o Similarities and difference of Uranus and Neptune with each other and with Jupiter and Saturn
  o Uranus’ lack of an internal heat source
  o Temperature profiles and cloud layers
  o Why are these planets blue?
  o Neptune’s Great Dark Spot
• Satellites and small planets with atmospheres:
  o Some satellites are bigger than some planets
  o What bulk density means in terms of composition and amount of volatiles
  o The gradient of volatiles in small bodies as you go outward in the solar system
  o The Galilean Satellites: how and why they are different, the role of tidal heating in their evolution
  o Titan: a satellite with a big atmosphere, why?, what’s it like there?, what roles do atmospheric source and loss processes play?, what role does the greenhouse effect play?, what role does UV sunlight play?
  o Triton, Pluto, and Charon: really icy bodies with thin atmospheres, cryovolcanism on Triton, tidally locked orbits of Pluto and Charon
• Life in the solar system:
  o What is life?
  o What is necessary for life to originate and for life to thrive?
  o The Miller-Urey experiments
  o What are likely candidates for life in our solar system and why? What are not likely candidates and why?
• Extrasolar planets:
  o What detection methods are used, and which have been successful so far?
  o Why are so many of the planets we’ve detected so different from our own solar system? (detection biases)