**INST 2403 STUDY GUIDE for Midterm 3 FALL 2017**

**Form of Exam**

* About 35 questions
* Mostly multiple choice plus a few short answer questions

**Suggestions**

* Review textbook readings, online Powerpoint slides
* Revisit the Warm-Up questions
* Look over the activities
* Take another look at the homework questions. In particular, take a look at the solutions after you committed to an answer
* It might help to go to the library and study other astronomy texts. Often reading an independent explanation in slightly different wording helps to understand a complex concept.

**Partial list of important concepts** (also see syllabus)

It’s probably a good idea to add to this list while studying for the exam.

* Formation of the Solar System
  + Solar system formed out of an collapsing rotating interstellar gas cloud
  + Theory of formation explains basically all properties of the system: flat disk, all object rotating counterclockwise, etc.
  + Temperatures were much higher back then
  + Temperatures fall off sharply with distance from center
  + At a certain distance the temperature was low enough so that planets could hold on to volatile gases 🡪 Jovian planets
* Earth and Moon
  + Earth’s atmosphere is mostly nitrogen, 1/5 oxygen
  + Moon does not have an atmosphere, is ¼ size of the earth (1/81 mass)
  + Moon: old highlands, younger maria due to lava outflow
  + Number of craters is an indication of age of surface
* Terrestrial Planets
  + Hard, rocky, dense, few moons, small (10x smaller than Jovians, 100x smaller than sun)
  + Runaway greenhouse effects on Venus (very hot) and Mars (very cold)
  + Venus is always covered in clouds, very dense atmosphere of CO2
  + Mars has very thin atmosphere, shows seasons, has weather, large surface structures, probably once had liquid water on its surface billions of years ago
* Jovian Planets
  + Mostly H & He, gaseous, big (10x bigger than terrestrial, 10x smaller than sun)
  + Rings, many moons
* Other objects
  + Asteroids are small (much smaller than the moon), located in asteroid belt between Mars and Jupiter
  + Comets are very small (few miles, city size) dirty traveling snowballs, tails point away from the sun (ion tail exactly, dust tail approximately), have highly eccentric and inclined orbits, when getting close to the sun, tails develop by outgassing of material, eventually comets break up, the leftover debris creates shooting stars if earth crosses the path of a defunct comet
* Greenhouse Effect
  + Due to atmospheric gases that make it hard for infrared radiation to travel in the atmosphere
  + Incoming sunlight gets absorbed by Earth’s surface then reemitted
  + Atmosphere absorbs radiation from sun and surface, reemits it into all directions, part is absorbed by earth’s surface which heats up
* Stellar Parallax
  + Geometric method to measure distances to close stars
  + Due to earth moving around the sun, stars seem to move wrt background stars
  + Parallactic angles are very small, semiannual movement is twice the parallactic angle
  + Inverse relationship between distance and parallactic angle: d = 1/p
* The Sun
  + Hot glowing gas ball made of H & He
  + 99.9% of all mass in solar system
  + Surface about 6000K, therefore radiation peaks in visible wavelengths
  + Core very dense, very hot (15 million K), extremely high pressure; these are necessary conditions for nuclear fusion to occur
  + Nuclear fusion: 4 H 🡪 1 He plus energy; He nucleus is lighter than 4 H nuclei, the mass difference *Δm* is converted into energy (*E = Δmc2*)
  + Energy output of the sun is immense, can be measured by the solar constant (each square meter on earth receives 1400W of power, i.e. 1400J of energy per second)
  + How much energy is being produced? To keep gravity at bay! Must have hydrostatic equilibrium: force of gravity pushing in, heat pushing out, the two must be exactly equal in strength so that the radius of the sun stays constant
* Stars
  + Hot glowing gas balls made of H & He
  + Have different colors, therefore must have different surface temperatures
  + Can measure and infer properties: mass, size, temperature, chemical composition (How?)
  + Two different concepts for “brightness”: power output of star itself is called luminosity L, how bright a star appears is captured by the apparent brightness B
  + Relation: *B = L/(4πd2),* falls off like distance squared, because light spreads out over surface of a sphere which has surface area *4πd2* where *d* is the radius of the sphere
  + Temperature, spectral type, color are equivalent
  + Review Stefan-Boltzmann law: L = P = A σ T4 = σ’ R2 T4
* Hertzsprung-Russell diagrams
  + Important tool to understand stars
  + Plot of luminosity as a function of temperature (or spectral type or color)
  + 90% of all stars are on the main sequence (normal stars: brighter if hotter)
  + Red giants & white dwarfs are abnormal (too bright/dim for their temperatures)
* Interstellar Medium
  + Gas & dust, made of H & He, very dilute, if contracts will form stars
* Stellar Lifecycle
  + Gas & duct cloud contracts, gets denser, hotter, forms protostar
  + If center is hot, dense enough nuclear fusion starts and object becomes a main sequence star
  + Must have enough mass to do so; mass varies from about 0.1 to 20 solar masses for a typical star, luminosities and life expectancies vary by 100 million!
  + Hot stars burn through hydrogen faster, die sooner
  + When hydrogen is depleted in core, stars generate energy by H shell burning, He burning, carbon burning; turn into red giants, then supergiants
  + Depending on mass, stars will end their lives differently
    - Small mass: shed outer layers, form planetary nebula, hot core becomes white dwarf
    - Mass bigger than 8 solar masses: core collapse supernova blows star apart
      * for massive stars: neutron star remains
      * for extremely massive star: black hole forms because gravity cannot be reined in by internal pressure
* Dead Stars (White dwarfs, Black Holes, Neutron Stars)
  + Extremely small and dense
    - Neutron stars: about city size, contain a whole star in that tiny volume!
    - Black hole: no size, shrinks to a dot (singularity), but has the same gravitational field as the original star, just can get much closer, therefore very strong field very close to singularity

**Sample Questions**

1. Red Giants sit where in the Hertzsprung-Russell diagram?

a. upper left corner

b. lower left corner

c. upper right corner

d. lower right corner

e. none of the above

2. Main-sequence stars with a mass smaller the sun …

* 1. …live longer
  2. …have larger radii
  3. …have a larger luminosity
  4. …have a larger surface temperature
  5. …have a larger core temperature

3. Two stars have the same chemical composition, spectral type, and luminosity class, but one is 4 light years from the Earth and the other is 40 light years from the Earth. The farther star appears to be …

a) 100 times fainter.

b) 10,000 times fainter.

c) 100,000,000 times fainter.

d) the same brightness since the stars are identical

4. Stars in the lower right corner of a Hertzsprung-Russell diagram

1. have small radii, large luminosity
2. large mass and small luminosity
3. high temperature and small life expectancy
4. low temperature and high life expectancy
5. none of the above

5. What is the single most important characteristic in determining the course of a star's evolution?

* 1. Absolute brightness
  2. Distance
  3. Surface temperature
  4. Mass
  5. Radius

1. Consider two stars with 2 solar masses (star A) and 0.5 solar masses (star B). Which is a true statement?
   1. Star A will live longer because it has more hydrogen to fuse.
   2. Star A will live 2 times shorter than star B.
   3. Star A will live 2 times longer than star B.
   4. Star A will live more than 2 times longer than star B.
   5. None of the above.
2. How did Jupiter’s location in the solar system affect its composition?
   1. Jupiter is rich in metals because only metallic grains could survive the low temperatures far away from the sun
   2. Jupiter is poor in metals because metallic grains cannot withstand these low temperatures
   3. Because Jupiter is so far away from the sun, it could hold on to volatile substances, such as helium and hydrogen
   4. None of the above
3. An ion tail of a comet always points
4. directly away from the sun.
5. directly toward the sun.
6. at an angle of 90 degrees to the sun direction.
7. There is no preferred direction.

**Short Answer Questions [3 points each]**

***(Please use the back side of the computer sheet to record your answers)***

9. Why are main sequence stars the brighter the hotter they are, while, on the other hand, red giants are so bright even though they have a relatively cool surface?

10. How does the luminosity, radius, mass and temperature of a star change as it develops from a main sequence star into a red giant?

11. Explain the greenhouse effect.