

Second Midterm - Your Name and ID:

Part Zero: Please write your name and student ID on the top line of this sheet **and** on the front of the Blue Book that you received together with this sheet. Please return both together for grading at the end of the exam. Please use a pen that cannot be erased!

Part One: True or False? Please mark with either T for True or F for False on the line provided in front of each statement. Each is worth one point:

1. Telescope design has to account for the chromatic aberration of the primary mirror.
False: Only lenses have chromatic aberration.
2. Without a proper eyepiece on the telescope a CCD or photographic film cannot be used to take a picture of a distant galaxy.
False: A flat photon recording device (like a CCD or a piece of photographic emulsion) can be mounted directly in the primary focus of the primary mirror or lens.
3. Adaptive optics elements are easier to use in the infrared than in the ultraviolet.
True: The longer wavelength means less stringent requirements on the correction that is to be applied.
4. Interferometry is used in radio astronomy to get around the limitation that diffraction places on the angular resolution of a single dish.
True.
5. The resolution of an X-ray telescope is typically limited by atmospheric seeing.
False: X-ray telescopes have to(!) be deployed above the atmosphere because X-rays cannot penetrate the atmosphere. So there will not be any atmospheric seeing in an X-ray telescope for the simple reason that it does not look through the atmosphere.
6. The objects in the Asteroid belt and in the Kuiper belt have different chemical composition.
True.
7. The Sun's rotation around its axis goes in the same direction as the planets move around the sun.
True. Two of the planets spin around their own axis in a direction different from the rotation of (almost) all other objects in the solar system, but even they follow their path around the sun in the same direction as all the other objects.
8. The conservation of angular momentum forces a dust cloud to contract into a disk structure rather than into a ball when it collapses to form a new star.
True.
9. The solar cycle is related to changes in the solar magnetic field.
True. (Although we do not know which is the chicken and which is the egg...)

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10. In the Sun energy transport from the core into the Radiation Zone is done by convection.
False: Radiation transports the energy out of the core into the Radiation Zone. Convection then transports the energy from the Radiation Zone into the Photosphere.

Part Two: Essay questions. Please explain your answer in a short (few sentences) essay that you enter into the Blue Book. Each is worth three points:

1. Please explain how the inner planets came to be rocky and the outer planets came to be gas giants. Which of the two types of planets reflects the overall chemical composition of the solar system and the universe as a whole?

Answer: The inner planets are made from unusually heavy elements. This happened because the young sun started to shine (radiate) before the dust cloud could settle into the disk and planets could form. The lighter gases (mostly Hydrogen and Helium, but also things like water that evaporate easily if heated by radiation) are pushed out by the pressure of this radiation. So by the time the disk is compact enough and planets form there are no more light elements or molecules in the vicinity of the sun. That also means that the composition of these inner planets is unusual: It has been depleted in the lighter elements. So the outer planets are the ones that are more representative of the elemental composition of the solar system and indeed the universe as a whole.

2. Please explain why it is good to have large mirrors on optical telescopes. For your answer assume that adaptive optics can be used to effectively eliminate atmospheric seeing.

Answer: There are two reasons: One is light collection, and the other is diffraction. Larger mirrors cover more area and therefore collect more light. Diffraction is the wavelength dependent limit on resolution imposed by the smallest effective aperture in the optical path. So a larger mirror is less limiting to the resolution of the telescope. (Spherical aberration on the other hand goes up, but can be corrected for to some extent.)

3. Why do sunspots usually come in pairs? How is such a sunspot pair connected?

Answer: Sunspots are places where the solar magnetic field breaks through the surface of the Sun. One of the sunspots will have the magnetic field lines come out of the surface through it, while the other will have these same magnetic field lines enter back into the Sun through it. So the sunspots are connected by magnetic field lines.

4. Please give an example for a selection bias in astronomy.

Answer: We discussed two examples of selection biases in class: One related to the observation that (almost) all the comets in the 200 year solar system animation converged onto the sun around the year 2000, and the other with the fact that almost all the planets we observed outside of our solar system are heavy planets close to their parent star.

5. Why do we think that our solar system is made from the debris of an older generation of stars? Give the definition of a metal as it is used in astronomy.

Answer: We think that precisely because there are metals in the makeup of the planets in

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our solar system. Metal in astronomy means anything heavier than Helium, and that relates to the fact that only Hydrogen and Helium were made in the aftermath of the Big Bang. To fuse Helium into heavier elements we need stars, and in order to get these elements out of the stars where they were made those stars need to die a violent death to eject the newly formed metals into interstellar space.

Grand total: 25 points. Hope it worked out for you!