

**Section 1**

**Astronomy 150**

**Fall 2010**

**Exam 3**

**Test Form A**

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1. **DO NOT OPEN THIS EXAM UNTIL INSTRUCTED TO DO SO.**
2. Write the multiple-choice answers on your Scantron form.
3. Make sure to mark your **test form, name, and NetID** on your form. I do not need anything else.
4. Answer *ALL* of the questions. There is no penalty for guessing.
5. Don't get stalled on any one question.
6. Choose the **best** answer for each problem.

**DO NOT FORGET TO FILL IN "TEST FORM" A**

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1. Which of the following is evidence for Dark Matter in our Galaxy?
  - A) The velocity of stars with distance from the center of the Galaxy does not drop off with the amount of stars, gas, or dust.
  - B) The huge gamma-ray jet at the center of our Galaxy.
  - C) The mass at the center of our Galaxy.
  - D) The orbit of the Earth around the Sun is slightly different than expected in Einstein's GR.
  - E) The orbits of our Galaxy with the Andromeda Galaxy.
  
2. We observe the CMB 180 degrees apart, i.e. on separate sides of the sky. What is the difference in the measured temperature of the two regions of the Universe that should never have been able to communicate since they are two age-of-the-universe light years away from each other?
  - A) The temperatures will be the same to within 1 K.
  - B) They will have very different temperatures.
  - C) The temperatures will be the same to within one part in 100,000.
  - D) The temperatures will be the same to within 0.1 K.
  - E) The temperatures will be the same to within one part in 100.
  
3. In 1-2 billion years the Milky Way and Andromeda will collide. During that time,
  - A) the gravity of the two galaxies interacts, changing the orbits of stars and possibly placing the Earth in a "bad" orbit.
  - B) the supermassive black holes will quickly merge and suck in the Earth, destroying it.
  - C) all large molecular clouds will collide, creating so much star formation that the Earth will be burnt to a crisp.
  - D) the Earth is pulled in two directions from the two galaxies, destroying life with crazy tides.
  - E) many stars will collide likely destroying our Sun.
  
4. An old 1 solar mass black hole enters our Solar System, headed right toward the Earth. What will likely be our first indication?
  - A) High energy photons from the accretion disk.
  - B) Gamma Rays or X-rays from the black hole's jet.
  - C) Orbits of the planets will change.
  - D) Nothing until it begins to feed on a planet.
  - E) Nothing until the Earth's tides become worse and worse.
  
5. What is the idea of panspermia for how life started on Earth?
  - A) That life started in the frying pan of life (i.e. hot primordial pools).
  - B) That life was formed around underwater sea vents.
  - C) That life started by pure chance.
  - D) That life was transported from space.
  - E) That the most extreme life currently on Earth are the first organisms.

6. What is the size of a black hole? Hint, at what radius does material that falls into the black hole end up?
  - A) An accretion disk that is directly proportional to the mass of the incoming material.
  - B) The event horizon.
  - C) It depends on the mass of the black hole.
  - D) A point, also called the singularity.
  - E) A disk, also called the Ergoregion.
  
7. Which of the following is not a type of Galaxy?
  - A) Spiral Nebulae
  - B) Spiral
  - C) Elliptical
  - D) Giant Elliptical
  - E) Irregular
  
8. If the Universe was ageless and infinite, what would the optical night sky look like?
  - A) Bright.
  - B) Full of Galaxies.
  - C) We would see many more stars in the Galaxy.
  - D) Like it does in radio waves-- CMB-like.
  - E) Dark like it is now.
  
9. Which of the following statements is **not** true about the Universe?
  - A) An older Universe will be less dense.
  - B) The early Universe was hotter.
  - C) The Universe was an explosion into empty space.
  - D) The early Universe was more dense.
  - E) The Universe is expanding.
  
10. Where did the Big Bang happen?
  - A) Everywhere.
  - B) In the outer reaches of the Galaxy, where we see Globular clusters today.
  - C) A little bit past the edge of the Universe.
  - D) Nowhere. It's like asking what is North of the North Pole.
  - E) At the edge of the observable Universe, which is why we see the CMB at 13+ billion light years away.
  
11. There are no Quasars in the nearby Universe today, but life on Earth could still be destroyed by quasar-like jets (assuming we are aligned with the jet) from the Andromeda Galaxy if
  - A) it collides with the Milky Way, instantly releasing bound gravitational energy.
  - B) the massive stars in the disk explode at once.
  - C) the Dark Energy in the Galaxy has a phase change, releasing unfathomable energy reserves.
  - D) we are unlucky and enter the death beam that all galaxies emit at low levels.
  - E) a stellar cluster falls into the center.

12. What object is most likely to enter the Solar System?
- A) A neutron star.
  - B) An M star.
  - C) An O star.
  - D) A white dwarf.
  - E) A black hole.
13. Our Universe could be one of three types: Open, Closed, or Flat. What would happen to a flat Universe?
- A) It would expand forever.
  - B) It would just barely expand forever.
  - C) It would expand for a while, and then eventually begin to re-collapse on itself.
  - D) It would expand, then slow down, and then expand faster.
  - E) It would eventually make all planets flat.
14. What will "Milkomeda" eventually look like?
- A) We have no idea since we don't know the "on-the-sky" velocity of Andromeda. There are many possibilities depending on the impact parameter.
  - B) A spiral nebula with an increased central mass.
  - C) A large spiral galaxy.
  - D) An irregular galaxy with long tails.
  - E) An elliptical galaxy.
15. What initial condition allowed the Milky Way to form?
- A) We don't know. Probably dark matter.
  - B) Nuclear strong force fields in the early Universe.
  - C) Quantum fluctuations in quark density in the early Universe.
  - D) Gravitational instabilities in the fabric of space-time.
  - E) Large super structures in the early Universe.
16. The Habitable Zone is defined as
- A) The zone around a planet where water will likely be liquid.
  - B) The zone around a star where water will likely be liquid.
  - C) Ocean front property.
  - D) The zone around a star where life will likely exist.
  - E) The zone around a planet where life will likely exist.
17. An alien astronomer on a galaxy 1 billion light years away from the Earth measures the velocity of our Galaxy. What does she measure?
- A) The Milky Way is moving toward her.
  - B) The Milky Way is rotating around her galaxy.
  - C) A motion that suggests that the Universe exploded billions of years ago.
  - D) The Milky Way is moving away from her.
  - E) The Milky Way is colliding with her galaxy.

18. What is at the center of our Galaxy?
- A) A supermassive black hole.
  - B) High density, interacting dark matter.
  - C) A supermassive stellar cluster.
  - D) We don't know. It is obscured with dust.
  - E) Likely a cluster of stellar cluster corpses, since all long lived objects eventually fall to the center.
19. Some people have claimed that particle accelerators (e.g. the LHC in Cern) can destroy the Earth with mini-blackholes or stranglets, but
- A) these particles are fictional.
  - B) the danger has been carefully calculated and assessed to be around 50/50, so worth the risk to solve the Universe's biggest puzzles.
  - C) those people are crazy.
  - D) cosmic rays with equivalent and bigger energies would have created these "bad" particles before, if it was possible.
  - E) the amount of energy to create these particles (i.e. to back before 0.001 seconds after the Big Bang) easily is still beyond the each of terrestrial accelerators.
20. Neumann Space Probe exploration of the Galaxy uses
- A) self-replicating spacecraft.
  - B) practical anti-matter drives.
  - C) radio waves.
  - D) warp drive capabilities.
  - E) multi-generational space colonies.
21. Why do we need Dark Energy?
- A) To explain the rotation curve of the Galaxy.
  - B) To explain the acceleration of the expansion of the Universe.
  - C) To explain the origin of black holes.
  - D) To explain dark matter.
  - E) To explain why we live in a closed Universe.
22. Why are we made out of matter and not anti-matter?
- A) It doesn't matter.
  - B) The Universe is only made up of matter.
  - C) The CMB ionized all of the antimatter at 400,000 years after the Big Bang.
  - D) The BBN created only matter a few seconds after the Big Bang.
  - E) There was a slight preference in matter at  $10^{-4}$  seconds after the Big Bang.

23. Which of the following is **not** a problem for interstellar space travel?
- A) Expense.
  - B) Speed.
  - C) Space is big.
  - D) Time.
  - E) Suitable stars.
24. What does the Drake equation really tell us?
- A) It calculates the number of advanced civilizations in the Universe.
  - B) It means nothing, a fake equation. It is only meant to guide our thinking about the relevant questions
  - C) It calculates the number of advanced civilizations in our Galaxy.
  - D) It gives us an exact number of alien lifeforms (intelligent or not) in the Galaxy.
  - E) It allows us to estimate the age of the Universe.
25. Where is everybody?
- A) Is the Obler Paradox.
  - B) Is the Drake Paradox.
  - C) Is the main question for this class.
  - D) Is the Fermi Paradox.
  - E) Is the Drake Equation.
26. How are we able to observe/detect the spiral arms in the Milky Way?
- A) We can't because we live inside the Galaxy. Can't see the forest for all the trees.
  - B) By observing the nearby molecular clouds that trace the arms.
  - C) By observing the O and B stars that trace the arms.
  - D) By observing the atomic hydrogen at 21 cm that traces the arms.
  - E) By observing nearby galaxies and observing their arms, then applying models of how our stars move to estimate our structure.
27. What does the color of a galaxy tell us about the age of the stellar population?
- A) If Gamma-ray bright, then full of black holes.
  - B) If X-ray bright, then recent stellar deaths.
  - C) If blue-ish, then recent star formation.
  - D) Nothing. The color only tells us the temperature of the star.
  - E) If red-ish, then recent star formation.
28. What drives a Quasar?
- A) Binary neutron stars colliding.
  - B) Variable stars.
  - C) A supermassive black hole surrounded by an accretion disk.
  - D) Stars that have a quasi-stable photosphere and huge flares.
  - E) Galaxies with very large supermassive black holes.

29. If we live in a forever expanding Universe, then which of the following will happen?
- A) Everything will fall into a single super-super-massive black hole that will explode into another Big Bang.
  - B) Nothing different will happen.
  - C) The supermassive black hole at the center of the Galaxy will accrete all stellar corpses.
  - D) Stars will burn heavier and heavier elements, creating elements that we have never seen.
  - E) The only galaxy to see will be our own.
30. Which of the following is evidence of the Big Bang?
- A) Einstein's law.
  - B) Cosmic Magnetic Background (CMB)
  - C) We are made out of matter not anti-matter.
  - D) Big Bang Nucleosynthesis.
31. How did hydrogen atoms first appear in the Universe?
- A) They existed since the Big Bang.
  - B) When the Universe cooled and the melted protons reformed, eventually gaining an electron.
  - C) When the Universe cooled and the hydrogen atoms fused into helium atoms, eventually gaining an electron.
  - D) When the Universe cooled and quarks combined to form the first protons, eventually gaining an electron.
  - E) When the Universe cooled and the antimatter turned into matter, eventually gaining an electron.
32. At Thanksgiving your uncle said that he was not getting heavier as much as the Universe is expanding, which makes him seem bigger. What's wrong with that argument?
- A) The Universe was expanding early on, during the inflationary period, but now it is not. So he is very wrong and misinformed.
  - B) He is not affected by the expansion of the Universe.
  - C) Time-space is a 4-dimensional volume inside of an 11-dimensional manifold. In that way the expansion of the Universe is responsible for your uncle's situation.
  - D) He is somewhat right. Without the expansion of the Universe, the food would not have enough calories.
  - E) He's right. The entire Universe is expanding.
33. Our Sun orbits the center of our Galaxy. We observe the motion of two stars, one is 10,000 light years closer to the center than the Sun and one is 10,000 light years farther away. Which star travels the fastest around the center of the Galaxy?
- A) The one farther out.
  - B) The one closer in.
  - C) The most massive one.
  - D) The Sun.
  - E) All of them travel the same speed.

34. As something falls directly into a black hole, it is stretched out because
- A) the speed of light is constant, making the object appear to be a thin long line.
  - B) the force of space-time funnels itself into the black hole.
  - C) the laws of physics break down.
  - D) of tidal forces.
  - E) orbital dynamics are circular, but under length contraction, everything will appear to be a thin long line.
35. Where is the Sun located in the Galaxy?
- A) The Galactic Halo.
  - B) In the center.
  - C) About 100 light years from the supermassive black hole.
  - D) In one of the spiral arms.
  - E) The disk, about 25,000 light years from the center.
36. What part of our Galaxy is made up of old stars?
- A) The nucleus.
  - B) The center.
  - C) The spiral arms.
  - D) The disk.
  - E) The halo.
37. How do we detect a black hole without an accretion disk?
- A) Optical light, watching the stars disappear.
  - B) We can't easily.
  - C) X-rays, black holes are still very bright.
  - D) Gamma-Rays in space, since gamma-rays are not affected by the atmosphere.
  - E) Infrared light since black holes are still at some temperature.
38. Which one of the following ways that astronomy may kill life on Earth has the most chance of happening within your lifetime?
- A) Galaxy collision.
  - B) Solar Evolution.
  - C) Black hole colliding with the Earth.
  - D) Alien invasion.
  - E) Supernova.
39. What particles make up a neutron?
- A) muons
  - B) quarks
  - C) leptons
  - D) electrons
  - E) nothing, it is a fundamental particle



40. It takes nearly 5 billions years for intelligent life to reach its current state on Earth. But, how long until an advance civilization could colonize the Galaxy?
- A) Much longer than a billion years.
  - B) It depends. If the warp drive is invented as expected, than less than 1 million years.
  - C) Also about 5 billion years.
  - D) Impossible. The galaxy is 100,000 light years in size.
  - E) Less than 150 million years.