

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 UIN 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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39. You are in a fast spaceship. You see the Earth slide past your window. You notice that you left a clock (readable from space), and for every second that passes on the spacecraft (and ignoring any gravitational effects)
- A) Time is redshifted.
  - B) Time has stopped.
  - C) Exactly 1 second passes on Earth.
  - D) Less than a second passes on Earth.
  - E) More than a second passes on Earth.
40. You go to a tall building in Chicago and drop a penny. Why does it fall?
- A) A penny is made from copper, so Earth attracts earth.
  - B) The Earth pulls it with instantaneous force.
  - C) Truly one of the fundamental problems in astronomy today. Which theory is actually correct, Einstein or Newton?
  - D) It follows the curve of space-time.
  - E) Air friction, i.e. more atmosphere above than below.
41. Is the Milky Way alone?
- A) No, we are part of a super rich cluster.
  - B) No, we are surrounded by massive galaxies.
  - C) No, we have lots of neighbor galaxies.
  - D) Yes, we are very away from all galaxies.
  - E) Yes, all galaxies are at cosmological distances.
42. Two galaxies collide, which of the following did **not** happen?
- A) The supermassive black holes will merge.
  - B) Gravity of the two galaxies interacts, changing the orbits of stars and modify the gas.
  - C) Star formation, if gas is available, is enhanced.
  - D) Large molecular clouds collide.
  - E) Stars collide.
43. As you pilot a federation spaceship to engage the replicators, which of the following weapons has the slowest speed?
- A) Gamma-ray beam.
  - B) Radio wave blaster.
  - C) Proton cannon.
  - D) X-ray beam.
  - E) Laser cannon.
44. If micro-black holes can be created by CERN, and if they do not vaporize instantaneously, why are we still not concerned about them?
- A) The chances are just too low.
  - B) Even if all true, black holes can only be made in supernovae. And I don't see any massive stars here.
  - C) There is only a 50/50 chance.
  - D) Cosmic rays would also make them, and we are still here.
  - E) It's in Switzerland, so there isn't much to lose.

45. There are three stars that orbit the Galactic Center: one is at the same distance from the Galactic Center as the Sun, one is 100 light years farther away from the Galactic Center, and one is 100 light years closer in to the Galactic Center. Over 230 million years, which star travels the most distance?
- A) The one at the Sun's orbit.
  - B) The one closer in.
  - C) The one farther out.
  - D) The most massive one.
  - E) All of them travel the same distance.
46. In Einstein's general relativity, a black hole is
- A) more of a gray color.
  - B) only created by the core collapse of a massive star.
  - C) where space-time is curved so much that light can never escape.
  - D) related to the curvature of the surface of the body.
  - E) only affected by other black holes.
47. What are quasars?
- A) Galaxies with extremely large star formation rates.
  - B) Quasi-stars.
  - C) Supermassive black holes in the center of a galaxy that is feeding.
  - D) Galaxies with very large supermassive black holes.
  - E) Variable stars.
48. You are at the back of a jet traveling at 400 mph. You shine a laser toward your friend in first class. What speed does your friend measure for the laser light?
- A)  $c-400$  mph
  - B)  $c/400$  mph
  - C)  $c/(c^2-400^2)$  mph
  - D)  $c$
  - E)  $c+400$  mph
49. What is the basis of the Fermi Paradox?
- A) Where are the extremophiles on the Moon or Mars?
  - B) Why are there so many species on Earth but none in space?
  - C) Where is everybody?
  - D) Where are UFOs being kept?
  - E) Why are there so many UFOs detected?
50. Life on Earth is
- A) only in special (not extreme) environments.
  - B) ubiquitous (i.e. everywhere).
  - C) probably very special.
  - D) a result of only about 1 billion years of evolution.
  - E) mostly complex animals.

51. The Milky Way is
- A) A spiral galaxy, with a supermassive black hole.
  - B) The center of the Universe.
  - C) A dwarf galaxy, with a supermassive black hole.
  - D) A barred spiral galaxy, with a supermassive black hole.
  - E) An elliptical galaxy, with a supermassive black hole.
52. Which of the following is not evidence of the Big Bang?
- A) Cosmic Microwave Background
  - B) We are made out of matter not anti-matter.
  - C) Hubble's law.
  - D) Big Bang Nucleosynthesis.
53. Arguably the simplest and cheapest way to explore the galaxy may be to
- A) develop some kind of practical anti-matter drive.
  - B) develop self-replicating space probes and hope they don't lose their programming.
  - C) develop multi-generational space colonies.
  - D) develop deep sleep human carriers.
  - E) develop warp drive capability.
54. If a black hole collides with the Earth, which of the following is **not** a possible consequence of the process?
- A) Earth is either ejected out of the Solar System, falls into the Sun, or falls into the black hole.
  - B) Earthquakes.
  - C) Tidal waves.
  - D) Spaghettification of the Earth.
  - E) The Earth turns into a white dwarf.
55. In our Galaxy, what is the strongest evidence for dark matter?
- A) Explanation of the formation of the Solar System.
  - B) Explanation of the Big Bang.
  - C) The flat rotation curve of the Solar System.
  - D) The flat rotation curve of the Galaxy.
  - E) Explanation of the expansion of the Universe.
56. Which of the following is **not** a problem for interstellar space travel?
- A) Space is big.
  - B) Expense.
  - C) Suitable stars.
  - D) Speed.
  - E) Time.
57. The seeds of Galaxies were due to?
- A) Large super structures in the early Universe.
  - B) Gravitational instabilities in the fabric of space-time.
  - C) We don't know. Probably dark matter.
  - D) Quantum fluctuations in quark density in the early Universe.
  - E) Nuclear strong force fields in the early Universe.

58. We are orbiting a stellar mass black hole. We launch a cubical probe toward the event horizon. What happens to the probe?
- A) Before it reaches the event horizon, it is stretched into the shape of a red egg.
  - B) When it reaches the event horizon, it is stretched into the shape of a red egg.
  - C) Before it reaches the event horizon, it stretches, turns red, and then is pulled apart by tidal forces.
  - D) Nothing happens until it reaches the event horizon, at which time it stops.
  - E) When it reaches the event horizon, it stretches, turns red, and then is pulled apart by tidal forces.
59. Nearly all galaxies are moving away from our Galaxy. What does this mean?
- A) We are the center of the Universe.
  - B) We are actually the only moving galaxy.
  - C) Dark Energy is causing universal repulsion.
  - D) All particles are repelling each other.
  - E) The Universe is expanding.
60. What is the CMB?
- A) Light at the edge of the Universe.
  - B) Coronal Mass Ball, a big Solar Storm
  - C) The Big Bang.
  - D) Noise from the atmosphere.
  - E) The hot early Universe redshifted down in wavelength.
61. Measurement of the CMB tells us that we live in a flat Universe, but the Universe is not massive enough to account for this. What do astronomers invoke to make up for this?
- A) Neutrinos
  - B) Black Holes
  - C) Dark Matter.
  - D) Dark Energy.
  - E) Dark Photons
62. Brooklyn isn't expanding. Why?
- A) Time-space is an illusion, Brooklyn doubly so.
  - B) Brooklyn is held together by stronger local forces.
  - C) The Universe was expanding early on, during the inflationary period, but now it is not.
  - D) It is. The entire Universe is expanding.
  - E) Brooklyn is special.
63. Our Universe could be one of three types: Open, Closed, or Flat. What would happen to an open Universe?
- A) It would expand for a while, and then eventually begin to re-collapse on itself.
  - B) It would expand forever.
  - C) It would expand, then slow down, and then expand faster.
  - D) It would be forever open to new Universes to interact with.
  - E) It would just barely expand forever.

64. You are in a spaceship traveling near light speed. You see the Earth move past your window, but it looks strange. What shape does the Earth look like from your point of view?
- A) Spherical, but bigger in all directions.
  - B) Redder in all directions.
  - C) Spherical, but smaller in all directions.
  - D) Egg-shaped or ellipsoidal, shorter along the direction of motion.
  - E) Egg-shaped or ellipsoidal, expanded along the direction of motion.
65. What particles make up a proton?
- A) nothing, it is a fundamental particle
  - B) muons
  - C) leptons
  - D) electrons
  - E) quarks
66. A non-accreting black hole enters the Solar System. How would astronomers first notice it?
- A) Weak, but detectable, Hawking radiation.
  - B) The big black part of space that gets bigger and bigger as it gets closer and closer.
  - C) Huge amounts of x-rays and gamma-rays emitted from it.
  - D) The first sign would be gentle stretching as we fall into the black hole.
  - E) Orbits in the Solar System are affected.
67. Which of the following would not cause the Milky Way galaxy to create a quasar-like jet?
- A) Two large clouds collide, falling into the center of the Galaxy.
  - B) A large star cluster falls into the center of the Galaxy.
  - C) A collision with Andromeda.
  - D) A massive black hole falling into the center of the Galaxy.
  - E) A large molecular cloud falls to the center of the Galaxy.
68. If an alien bacteria or virus lands on Earth it is unlikely to be seriously dangerous to humans why?
- A) They are too little to make any difference.
  - B) It is totally impossible for alien bacteria or viruses to land on Earth.
  - C) Terrestrial bacteria or viruses have evolved to become dangerous to humans.
  - D) The Drake Equation proves that space traveling ET life can not exist.
  - E) No hands. No ray guns.
69. Which of the following statements is **not** true about the Universe?
- A) The earlier Universe was more dense.
  - B) An older Universe will be less dense.
  - C) The Universe is expanding.
  - D) The Universe was an explosion into empty space.
  - E) The earlier Universe was hotter.
70. If an advanced civilization wants to colonize the Galaxy, it should
- A) be possible if humans can evolve into a human/machine hybrid.
  - B) be impossible for two different species to meet.
  - C) be possible if the speed of light restriction is overcome in some way.
  - D) be possible in less than 150 million years.
  - E) be impossible even in billions of years.

71. Where is the Sun located in the Galaxy?
- A) About 100 light years from the supermassive black hole.
  - B) The disk, about 25,000 light years from the center.
  - C) One of the spiral arms.
  - D) The disk, about 500 light years from the supermassive black hole.
  - E) The Galactic Halo.
72. What is special about the night sky? (Hint: This is especially in reference to Olber's Paradox.)
- A) It's infinite.
  - B) It is ageless.
  - C) It's bright.
  - D) It's finite.
  - E) It's dark.
73. As spiral arms are not permanent features, but density waves, temporarily trapping gas and stars. This means that the Earth could collide with a molecular cloud at some point in the future. What would happen to the Earth in that case?
- A) Quench the Sun, turning off fusion for a short time.
  - B) Interact with the upper atmosphere, causing loss of ozone.
  - C) Crash into the Sun, causing an accretion disk.
  - D) Crash into the Earth, making small meteors, and destroying the atmosphere.
  - E) Reduce the amount of sunlight received by the Earth.
74. If we live in a forever expanding Universe, then which of the following would **not** happen?
- A) The only galaxy to see would be our own.
  - B) Protons will likely decay.
  - C) Eventually, all the stars will burn out.
  - D) All the black holes will evaporate.
  - E) The supermassive black hole at the center of the Galaxy will accrete all stellar corpses.
75. Which extinction on Earth might have been due to a GRB?
- A) 250 Myrs ago: The Permian-Triassic Event
  - B) 205 Myrs ago: The Permian-Triassic Event
  - C) 360 Myrs ago: The Late Devonian Event
  - D) 65 Myrs ago: The Cretaceous-Tertiary (KT) Event
  - E) 450 Myrs ago: The Ordovician-Silurian Event