

**Section 1**

**Astronomy 150**

**Fall 2010**

**Exam 2**

**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. ~~When the Sun is on the main sequence, it is near the center of the HR diagram. As the Sun evolves to a Red Giant, which way does it move on the HR diagram?~~
  - A) ~~Up and to the left.~~
  - B) ~~Down and to the left.~~
  - C) ~~Straight up.~~
  - D) ~~Down and to the right.~~
  - E) ~~Up and to the right.~~
  
2. ~~In Einstein's general relativity, a black hole is~~
  - A) ~~only created by the core collapse of a massive star.~~
  - B) ~~more of a gray color.~~
  - C) ~~where space-time is curved so much that light can never escape.~~
  - D) ~~only affected by other black holes.~~
  - E) ~~related to the curvature of the surface of the body.~~
  
3. As a massive star ages, its interior structure most closely resembles
  - A) an ogre, getting ready to explode at any minute.
  - B) an onion, the layers of fusion.
  - C) a diet Coke and Mentos, about to fizz.
  - D) Swiss cheese, the holes from convection.
  - E) an orange, all the pips from heavy elements.
  
4. When the Sun evolves to the Horizontal Branch, what will be fusing?
  - A) Silicon into iron in the core.
  - B) Helium into carbon in the core.
  - C) Helium into carbon in a shell around the core.
  - D) Hydrogen into helium in the core.
  - E) Nothing in the core.
  
5. Why is creating fusion on Earth so difficult?
  - A) Need exotic mass particles, neutrinos, which don't exist on Earth, to glue the protons together.
  - B) Need freaky high temperature and pressure, which are hard to make on Earth, to overcome the natural repulsion of protons.
  - C) Need to destroy hydrogen with antimatter, which is very difficult to make on Earth.
  - D) It is impossible to create the conditions for fusion on Earth.
  - E) Need a strong nuclear force field, which requires high gravity fields, nearly impossible to make on Earth.

6. ~~You go to a tall building in Chicago and drop a penny. Why does it fall?~~
- ~~A) It follows the curve of space-time caused by the mass of the Earth.~~
  - ~~B) Air friction, i.e. more atmosphere above than below.~~
  - ~~C) A penny is made from copper, so Earth attracts earth.~~
  - ~~D) The Earth pulls it with instantaneous force.~~
  - ~~E) Truly one of the fundamental problems in astronomy today. Which theory is actually correct, Einstein or Newton?~~
7. Right before a supernova occurs, what happens in the core?
- A) Collapsing into a supernova.
  - B) Gravity was overcome.
  - C) Collapsing into a blackhole.
  - D) Collapsing at the speed of light.
  - E) Burning silicon into iron.
8. What is a planetary nebula?
- A) The glowing remains of a low-mass star as it evolves into a Red Giant.
  - B) A round nebula that formed when the planets formed from a protostar.
  - C) The glowing remains of a molecular cloud clump that will likely form a planetary system.
  - D) The glowing remains of the envelope of a low-mass star.
  - E) The glowing remains of a high-mass star. It is the outer envelope that is cast off right before a supernova explosion.
9. Why are hypernova so bright?
- A) They are supernova on steroids.
  - B) They are far away.
  - C) They are beamed.
  - D) They are isotropic.
  - E) They are the biggest, most massive stars.
10. What is the temperature of a sunspot compared to the surface of the Sun?
- A) Much cooler
  - B) Slightly hotter
  - C) Slightly cooler
  - D) About the same
  - E) Much hotter

11. Which of the following would happen if a nearby (~7000 light years) hypernova happened with its beam toward Earth?
  - A) Create reddish-brown smog (nitrogen dioxide) that reflects light from the Sun back into space from gamma-ray interaction with atmosphere.
  - B) Destroy all of the natural Earth muons (heavy electrons) that allow plants to create oxygen.
  - C) Create an electromagnetic pulse that would rip the electrons from our bodies.
  - D) Ozone layer increased so much that sunlight is blocked.
  - E) Create a gravitationally instability in the Earth's atmosphere that would likely cause instant and multiple instances of hurricanes.
  
12. Which extinction on Earth might have been due to a GRB?
  - A) 65 Myrs ago: The Cretaceous-Tertiary (KT) Event
  - B) 360 Myrs ago: The Late Devonian Event
  - C) 250 Myrs ago: The Permian-Triassic Event
  - D) 450 Myrs ago: The Ordovician-Silurian Event
  - E) 205 Myrs ago: The Permian-Triassic Event
  
13. What is powering a GRB?
  - A) Pulsar pulses.
  - B) A neutron star.
  - C) X-ray lasers pump the energy up to Gamma Rays.
  - D) A black hole with an accretion disk.
  - E) A supernova.
  
14. ~~Since fusion is over, what supports a neutron star from collapsing?~~
  - ~~A) Neutron degeneracy.~~
  - ~~B) Molecular degeneracy.~~
  - ~~C) Atomic degeneracy.~~
  - ~~D) Heat.~~
  - ~~E) Electron degeneracy.~~
  
15. A large CME happened last week. What's the most likely reason why the Earth was not affected?
  - A) It didn't hit the Earth.
  - B) It didn't have strong enough magnetic fields.
  - C) It didn't have enough mass.
  - D) The satellites gave enough warning to protect everyone and everything that could be destroyed.
  - E) It was deflected by the Earth's magnetic field.

16. In 1829 a massive CME impacted the Earth, but the damage was minimal. In that case, why do we carefully monitor the Sun today?
- A) We were lucky that the CME hit the dark side of the Earth, so the damage could have been much worse.
  - B) We are more reliant on technology that can be affected.
  - C) The Earth's average temperature is much higher today.
  - D) The population density is much higher now.
  - E) The Moon's magnetic field deflected most of the particles, so the damage could have been much worse.
17. As you pilot a federation spaceship to engage the replicators (enemies of Earth), which of the following weapons has the slowest speed?
- A) Laser cannon.
  - B) X-ray beam.
  - C) Proton cannon.
  - D) Radio wave blaster.
  - E) Gamma-ray beam.
18. Why does Leslie keep saying that we star stuff?
- A) We are just stuff, like stars.
  - B) Because he's nuts.
  - C) We are made up of small bits and pieces of stars.
  - D) We also use fusion as a power source.
  - E) We are made up of the elements that were forged in the interior of stars.
19. Which of the following stars will supernova and turn into a blackhole?
- A) 100 solar mass
  - B) 5 solar mass
  - C) 0.5 solar mass
  - D) 10 solar mass
  - E) 1 solar mass
20. The density of a neutron star is
- A) about the same as that of the sun.
  - B) about the same as an atomic nucleus.
  - C) about the same as a water molecule.
  - D) smaller than expected because the magnetic field is so strong.
  - E) about the same as that of a white dwarf.

21. ~~If the Moon suddenly turned into a black hole, what would be the largest effect on the Earth?~~
- ~~A) The increase in mass would make the tides tenfold larger, destroying much of the waterfront population.~~
  - ~~B) The Moon would spiral inward, causing a giant hole in the Earth.~~
  - ~~C) The Earth would fly out of the Solar System.~~
  - ~~D) Since it is less than a few Earth radii away, the Earth would be sucked into the black hole.~~
  - ~~E) Nothing.~~
22. If stars are all powered by nuclear fusion, then why are they different colors?
- A) They have different brightnesses.
  - B) They are at different distances.
  - C) They have different radii.
  - D) They have different masses.
  - E) They have different temperatures.
23. ~~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) Less than a second passes on Earth.~~
  - ~~B) Time is redshifted.~~
  - ~~C) Exactly 1 second passes on Earth.~~
  - ~~D) Time has stopped.~~
  - ~~E) More than a second passes on Earth.~~
24. What causes a high-mass star to leave the main sequence?
- A) A shell around the core begins to burn hydrogen while the core is still burning hydrogen.
  - B) Runs out of helium in the core.
  - C) Runs out of hydrogen in the core.
  - D) Supernova.
  - E) Runs out of silicon in the core.
25. As the Sun evolves into a Red Giant, the Earth may or may not be swallowed. Why might the Earth be swallowed?
- A) As the Sun expands, Electron degeneracy pressure pushes the Earth farther out into the Solar System, but not far enough.
  - B) The Sun's core is supported by electron degeneracy, so the expansion rate is unknown. So, it might get swallowed.
  - C) If the Sun does not lose enough mass in a stellar wind, the Earth will not move away in time.
  - D) It will depend on how much hydrogen is lost in the core, since it is inversely proportional to the increase in size; if the amount of hydrogen is small, then the Earth will be swallowed.
  - E) If the Sun gets bigger, the Earth is pulled more strongly by gravity.

26. 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)  $c - 400 \text{ mph}$
  - B)  $c + 400 \text{ mph}$
  - C)  $c/400 \text{ mph}$
  - D)  $c/(c^2 - 400^2) \text{ mph}$
  - E)  $c$
27. Observations from the Compton Gamma Ray Observatory showed that gamma-ray bursts were located uniformly throughout the sky. This told us that
- A) the bursts are associated with the Big Bang.
  - B) gamma rays are easily produced by very cold material.
  - C) the bursts were not from stars in our galaxy.
  - D) supernovae are very common.
  - E) the bursts are not associated with neutron stars or black holes.
28. What major constituent of our atmosphere was mostly missing more than 2 billion years ago?
- A) Water vapor
  - B) Oxygen
  - C) Carbon
  - D) Water
  - E) Nitrogen
29. Neutrinos are detected from the Sun. What does this imply?
- A) Nothing. All stars emit neutrinos, even supernovae.
  - B) The Sun is a Gamma Ray Burst.
  - C) The Sun is powered by nuclear fusion.
  - D) The Sun is a blackbody with a temperature of 5800K.
  - E) The Sun is a powerful source of energetic particles.
30. As the Sun evolves on the main sequence, what is the best mitigation technique?
- A) Use a few small asteroids to gravity assist the Earth outward.
  - B) Use asteroids to move the Sun farther away.
  - C) Terraform Venus and move there.
  - D) Use an asteroid to transfer orbital energy from Jupiter to Earth, moving the Earth outward.
  - E) Use asteroids to crash into the Sun, cooling it.
31. Why don't all supernova remnants contain pulsars?
- A) Pulsars can only be produced with low metallicity stars, which are only in the early Universe.
  - B) Pulsars slow down and quite producing the pulses before the supernova remnant dissipates.
  - C) All supernova remnants do contain pulsars.
  - D) Some supernova explosions form white dwarfs instead of the objects necessary for pulsars.
  - E) The pulsar may be angled so that the beams do not sweep past Earth.

32. As the Sun ages over the next 1 billion years, how will its properties evolve?
- A) It will run out of hydrogen in the core and begin to turn into a red giant, but we don't know how big it will get.
  - B) It will still be on the main sequence, so the main properties will not change.
  - C) It will stay on the main sequence, getting a little more luminous.
  - D) It will shrink slightly and heat up as the core uses up the hydrogen in the center reducing the pressure pushing against gravity.
  - E) It will turn into a planetary nebula.
33. How close is too close for a supernova to cause significant damage to the Earth?
- A) Anywhere in space if it is beamed toward us.
  - B) In our Galaxy
  - C) 15 light years
  - D) 150 light years
  - E) 5000 light years
34. The HR diagram plots
- A) luminosity and mass.
  - B) luminosity and size.
  - C) temperature and age.
  - D) temperature and luminosity.
  - E) mass and size.
35. What is the danger from a nearby supernova to the Earth in the next million years?
- A) 100%, Sirius B is going to blow!
  - B) Zero. There are no stars close enough.
  - C) 100%, Betelgeuse is going to blow!
  - D) 100%, eventually it will happen and 1 million years is a long time.
  - E) Zero. There are no stars close enough and massive enough.
36. For the corpses of stars, the more massive the object
- A) the redder.
  - B) the older.
  - C) the deader.
  - D) the smaller.
  - E) the bigger.



37. When we observe the Sun in optical light, we see a continuous rainbow of color with some color gaps. Why?
- A) Thermonuclear fusion only emits certain colors.
  - B) Any glowing gas, like we saw in class, emits at only certain wavelengths. So, we are seeing many many elements emitting light, with only a few elements missing.
  - C) Anything that has a temperature emits light in that way.
  - D) The Sun is a blackbody and the missing colors are elements (like hydrogen) absorbing the light and re-emitting it in all directions.
  - E) Some light is blocked by the Earth's atmosphere.
38. Where did the iron in your blood originally come from?
- A) The Big Bang.
  - B) The crab nebula.
  - C) A planetary nebula.
  - D) A supernova.
  - E) A neutron star.
39. Two stars are formed in a binary system at the same time. One is a 1 solar mass star and the other is a 2 solar mass star. Which one becomes a Red Giant last?
- A) The 2 solar mass star will not turn into a Red Giant. It is massive enough to turn into a Red Supergiant.
  - B) It is impossible to know without specifying the distance.
  - C) The 1 solar mass star.
  - D) The 2 solar mass star.
  - E) It is impossible to know without specifying the temperature and spin of the two stars.
40. On the HR diagram, where do we find very small and very hot stars?
- A) Exact middle.
  - B) Bottom left.
  - C) Upper left.
  - D) Upper right.
  - E) Bottom right.