Astronomy C - Astronomy - Pearl City Invitational - 12-12-2020

46 questions, 125 points, 50 minutes.

There is a mix of easy questions and more challenging questions, in no particular order. Good luck!

General Knowledge and Optics

1. (1.00 pts)   From the point of view of a Calendar maker, almanac maker, or watcher of the skies, December 21 every year has a special name. It is called _____ _____

2. (1.00 pts)   If you lived in Antarctica, would the above name for December 21 seem reasonable to you? Explain.

3. (2.00 pts)   On December 21 this year, stargazers are looking forward to a very special phenomenon. What is that?

4. (2.00 pts)   Seen from the Earth, what is the approximate angular size of the full moon in degrees? How about in arc minutes?

5. (2.00 pts)   Total solar eclipses can sometimes be seen from the Earth. What can you deduce about the approximate angular size of the Sun as seen from the Earth?

6. (2.00 pts)   What is the approximate range of wavelengths of visible light in Angstroms?

7. (5.00 pts)

The "aperture" of the dark-adjusted human eye is about 8 mm. What is the theoretical angular resolution of the human eye at a wavelength of 500 nm, in units of radians? How about in units of arc minutes?

8. (2.00 pts) How many arc seconds is a radian?

9. (1.00 pts) What is an Astronomical Unit (AU)?

10. (2.00 pts) How many AU is a parsec?

11. (2.00 pts)

Suppose two objects are so close in the sky that they are separated by 1/8 (one-eighth) the angular size of the full moon. By how many arc minutes are they separated?

12. (3.00 pts)

Assume the actual angular resolution of the human eye is the same as what you calculated above for its theoretical angular resolution. Consider those two objects in the sky that are separated by only about 1/8 the angular size of the full moon. Would the human eye be easily able to distinguish them as two separate objects?

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13. (2.00 pts)   On December 21 this year, will the two astronomical objects that stargazers are eagerly watching appear as a single object or as two separate objects?

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14. (2.00 pts)   Which of the following names is the "odd woman out"?

- ○ A) Vera Rubin
- ○ B) Henrietta Leavitt
- ○ C) Cecilia Payne
- ○ D) Annie Cannon
- ○ E) Jennifer Doudna

Stars

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15. (2.00 pts)   The Sun is "powered" by:

- ○ A) Chemical reactions
- ○ B) Nuclear fission
- ○ C) Release of gravitational potential energy by contraction
- ○ D) Nuclear fusion
- ○ E) Abdominal contractions

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16. (2.00 pts)
The Sun radiates about 4 x 10^26 Joules per second. Nowadays, this large and long-term production of energy can be explained by nuclear physics, mass-energy equivalence, and quantum physics. These ideas emerged only in the first 3-4 decades of the 20th century. Before then, what was the best available scientific theory for the Sun's release of energy?

- ○ A) Chemical reactions
- ○ B) Release of gravitational potential energy by contraction
- ○ C) Nuclear fission
- ○ D) Tidal forces
- ○ E) Magnetohydrodynamic effects

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17. (3.00 pts)
However, this explanation for the Sun's energy production was already realized to be inadequate, due to discoveries from geology and fossil evidence. In what way did the geological evidence conflict with the above theory for explaining how the Sun generates energy?

18. (2.00 pts)   However, the energy released by a certain category of stars is in fact due to this phenomenon, rather than nuclear fusion. What is that category of stars?

○ A) Pre-Main Sequence stars

○ B) Main Sequence stars

○ C) Red Supergiants

○ D) Red Giants

○ E) White dwarfs

19. (1.00 pts)
The temperature at the core of the Sun is believed to be about 16 million degrees Kelvin. What is the dominant process by which nuclear fusion occurs in the Sun's core?

○ A) CNO cycle

○ B) Triple alpha process

○ C) Proton-proton chain reaction

○ D) Proton-neutron chain reaction

○ E) Deuterium fusion

20. (2.00 pts)   In a star like the Sun, the heaviest element produced in the core by nuclear fusion is

○ A) Iron

○ B) Nickel

○ C) Helium

○ D) Uranium

○ E) None of the above

21. (2.00 pts)   After leaving the main sequence, the Sun is expected to eventually undergo a "helium flash."

○ True   ○ False

22. (3.00 pts)   Asteroseismology is the study of the oscillations (vibrations, pulsations) of stars. Data from asteroseismology can give us information about:

○ A) The approximate age of the star

○ B) The internal structure of the star

○ C) The distance to the star

○ D) All of the above

○ E) Only A and B

23. (3.00 pts)   Which of the following types of star has the lowest maximum mass?

○ A) White dwarf

○ B) Brown dwarf

○ C) Red dwarf

24. (3.00 pts)   Which of the following is true about the so-called "Lithium test"?

○ A) Lithium is generally present in brown dwarfs, but not in low-mass main sequence stars

○ B) Lithium is generally present in low-mass main sequence stars, but not in brown dwarfs

○ C) Lithium can be fused in the more massive brown dwarfs

○ D) Both A and B

○ E) Both A and C

25. (3.00 pts)   Which of the following statements is true?

○ A) Wolf-Rayet stars have broad emission lines in their spectrum

○ B) Wolf-Rayet stars are very hot and luminous

○ C) A Wolf-Rayet galaxy has many Wolf-Rayet stars

○ D) Wolf-Rayet stars are unlikely to be found in globular clusters

○ E) All of the above

Galaxies

26. (1.00 pts)   There are about as many galaxies as there are stars

○ True   ○ False

27. (3.00 pts)   Which of the following statements are true about spiral galaxies?

○ A) Some spiral galaxies are reddish

○ B) Some spiral galaxies have very little star formation going on

○ C) Most galaxies in the Local Group are spiral galaxies

○ D) The gaps between spiral arms have very few stars and almost no gas and dust

○ E) A and B

28. (3.00 pts)   Which of the following statements is true?

○ A) None of the following options is true

○ B) Core collapse supernovae are often observed in elliptical galaxies

○ C) Elliptical galaxies are rich in gas but not in dust

○ D) Due to mergers and interactions between galaxies, elliptical galaxies tend to evolve into spirals

○ E) Elliptical galaxies rarely have globular clusters

29. (1.00 pts)   In general, collisions or close interactions are thought to be more common for stars than for galaxies

○ True   ○ False

30. (3.00 pts)   Which of the following statements is true about the Tully-Fisher relation?

○ A) It gives an empirical relationship between rotational speed and luminosity for spiral galaxies

○ B) It can be used to estimate the distance to many spiral galaxies

○ C) One of the astronomers for which it is named works at the University of Hawaii

○ D) An analogous relationship called the Faber-Jackson relation has been found for elliptical galaxies

○ E) All of the above

31. (3.00 pts)   Which of the following is the largest type of gravitationally bound structure?

○ A) Superclusters

○ B) Galaxy groups

○ C) Globular clusters

○ D) Galaxy clusters

32. (3.00 pts)   What is the Galaxy Zoo project? Name at least one interesting discovery that came out of this project.

33. (4.00 pts)   What is meant by the "flattened rotation curve" of spiral galaxies?

34. (4.00 pts)
What is a starburst galaxy? Be specific: compare (specific:compare) with the Milky Way. What kind of event may trigger a starburst? What phenomena may eventually "quench" a starburst?

35. (4.00 pts)   What is the Lyman alpha forest? How is it thought to be formed? What kind of information can it give us?

Cosmology

36. (2.00 pts) About how many percent of the total mass-energy content of the Universe is thought to be electromagnetic radiation?

○ A) About 68%

○ B) Less than 5%

○ C) Less than 0.1%

○ D) About 27%

37. (1.00 pts) About how many percent of the mass-energy content of the Universe is thought to be dark matter?

○ A) About 27%

○ B) Less than 0.1%

○ C) About 68%

○ D) Less than 5%

38. (1.00 pts) About how many percent of the mass-energy content of the Universe is thought to be baryonic (ordinary) matter?

○ A) About 68%

○ B) About 27%

○ C) Less than 5%

○ D) Less than 0.1%

39. (4.00 pts) Four fundamental forces are known to physics. List them in order of weakest to strongest.

40. (3.00 pts) Dark matter is thought to interact by means of which of the four fundamental forces?

41. (5.00 pts)
Although the "Big Bang" theory of the origin of the Universe is dominant today, up to the 1950s or 1960s there was an influential alternative theory. What is that theory called? Explain it briefly. What specific prediction does it make about the Universe of the distant past?

42. (3.00 pts)
Astronomers generally subscribe to the so-called "Cosmological Principle", which postulates that the Universe is homogenous and isotropic. What is meant by homogenous? What is meant by isotropic?

43. (5.00 pts)   What is Olbers' Paradox? If the Universe is indeed homogeneous and isotropic, what prediction does it make?

44. (4.00 pts)   How does Big Bang cosmology resolve Olbers' Paradox?

45. (10.00 pts)   Describe and characterize the Cosmic Microwave Background in up to 10 sentences (1 point per meaningful fact, up to 10 points).

46. (3.00 pts)
This question is just for fun and creativity. Three points extra credit. There is a star called Zubenelgenubi (also called Alpha Librae). Like many star names, it is Arabic. To me, "Zubenelgenubi" almost sounds like a line from a song.   :-)   Write something fun (song, poem, joke, riddle...) using the word Zubenelgenubi. Keep it non-offensive.

I hope that you found the test questions interesting. Good luck with your other events.

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