Astronomy 0113: Exam 3

13-Dec-1996

Please write clearly. Marks will be deducted for untidy work. Questions may be done in any order but they **must be labelled clearly**. Leave a few lines between each question. The marks for each question are indicated.

In Section A, only the answer need be given unless explicitly stated otherwise. If a justification is needed, it need only be a few lines long.

Questions in Section B require a longer answer, and are worth more. A simple answer for these questions will **NOT** suffice — **you must indicate your reasoning**. All working must be shown, symbols should be defined, and units must be provided for the final answer. Partial marks will be awarded for incomplete or incorrect answers. If you feel that your answer is incorrect because you may have made some mistake, indicate why you think this.

The EXAM is worth a total of 150 marks.

Section A [60 marks]

1. Give 2 important differences between Population I and Population II stars in our galaxy. Be sure to indicate which is which.

   (2 marks)

2. List the main sequence spectral types in order of INCREASING lifetime.

   (2 marks)

3. The moon is observed to set 1 hour before sunset. What moon phase is it?

   (2 marks)

4. Which celestial object moves approximately 1° east with respect to the background stars each day?

   (2 marks)

5. A galaxy has a luminosity of $10^{10}\,L_\odot$. From its morphological properties we know that such a galaxy generally has a mass-to-light ratio of 3. What is the "best" estimate for the galaxy's mass? (2 marks)

6. A star has distance of 50 kpc from the Earth. What spectroscopic parallax would be observed?

   (2 marks)

7. A normal galaxy is rich in gas and dust but shows no evidence for spiral structure. What type of galaxy is it?

   (2 marks)

8. The 2-dimensional analogue to a flat universe is the surface of a ?

   (2 marks)

9. Why are rotation curves useful?

(2 marks)

10. If our universe had a density ABOVE the critical value, what structure would this imply?

(2 marks)

11. Stars on the Main Sequence obtain their energy from what source?

(2 marks)

12. Quasars are believed to be powered by ?

(2 marks)

13. Quasars, radio galaxies, and seyfert galaxies are all examples of what type of galaxy? (2 marks)

14. If the mass of a black hole is doubled, by what factor does the size of the event horizon increase?

(2 marks)

15. The event horizon of a black hole refers to?

(2 marks)

16. Star A is at a distance of 1 kpc. An astronomer observing this object detects 100 photons per second. If the star were moved to 2 kpc from Earth, how many photons per second would the astronomer detect with exactly the same telescope and instrumentation? Ignore the effects of interstellar extinction. (3 marks)

17. Star A has an apparent magnitude of 3, and star B has an apparent magnitude of 5. Which star is brighter, and by what factor?

(1+2 marks)

18. The lifetime of a $1\,M_{\odot}$ star on the main sequence is approximately 10^{10} years. Which of the following [3×10^{12} years, 5×10^{10} years, 10^{10} years, 3×10^{8} years] would be the best estimate of the lifetime on the main sequence of a star with mass of $0.5\,M_{\odot}$. Indicate the reason for your answer.

(1+2 marks)

19. What is the positron? What is its mass and charge (in terms of that of the proton, electron, or neutron)?

(3 marks)

20. After quasars were first discovered it took some time before their spectra were understood. Why?

(3 marks)

21. The principal observational reason that we believe the Universe to be homogeneous and isotropic on large scales is (4 key words)?

(3 marks)

22. Which three quantities fully specify the properties of a black hole?

(3 marks)

23. A distant galaxy is observed to have a radial velocity of $4000\,\mathrm{km\,s^{-1}}$. Is the galaxy moving towards us or away from us? What is the galaxy's distance? What is the name of the law you used to derive this distance?

(1+2+1 marks)

24. What does the following equation describe? Define all terms.

$$P = nkT$$

(5 marks)

Section B [**90 marks**]

25. A rotation curve of a galaxy shows a velocity of $200\,\mathrm{km\,s^{-1}}$at 10 kpc. Beyond 10 kpc the rotation curve is Keplerian. What does this mean/imply (2 key ideas)? What would be the rotation velocity at 40 kpc?

(6 marks)

26. In S.I. units the Stefan Boltzmann constant is equal to $5.67 \times 10^{-8}\,\mathrm{J\,m^{-2}\,s^{-1}\,K^{-4}}$. Given that 1 Joule=$10^7$ergs, convert the Stefan Boltzmann constant to c.g.s. units (erg, cm, s, K). (6 marks)

27. Using a parallel list, list 4 key differences between elliptical and spiral galaxies. (8 marks)

28. What is 21cm radiation? Discuss the transition giving rise to the radiation, and indicate when emission/absorption of a photon occurs. A diagram might be beneficial. Why is 21cm radiation useful to astronomers?

(8 marks)

29. At what wavelength does the spectrum of a 20,000 K blackbody peak? In which spectral region does this occur? What is the name of the law you have used? If the star has a radius of $10\,R_{\odot}$ what is its luminosity? (4+2+2+4 marks)

30. Derive the maximum and minimum angular diameter of Jupiter as viewed from the Earth. The average distance of Jupiter from the Sun is 5.2 A.U. and the linear diameter of Jupiter is 11 times that of Earth. Assume that the orbits of both Jupiter and Earth about the Sun are circular, and in the same plane. Draw a diagram.

(10 marks)

31. Spectroscopy plays a key role in astronomy. Define spectroscopy, and then discuss what astronomers can learn using spectroscopy.

(10 marks)

32. Discuss and contrast the differences in properties of White Dwarf stars, Neutron stars, and Black Holes. You should discuss such properties as size and mass, what Main Sequence mass range they are produced by, how we know they exist etc.

(15 marks)

33. Discuss the large scale structure and evolution of the Universe. Issues you might like to address include the geometry of the Universe, its age, the expansion of the Universe, the Big Bang theory and why the Steady State theory is unacceptable, the microwave background radiation and what it tells us, etc.

(15 marks)