BROCK UNIVERSITY

Test 1: June 2015
Course: ASTR 1P02, Section 2
Examination date: 20 June 2015
Time of Examination: 13:00 – 13:50

Number of pages: 10
Number of students: 1
Time limit: 50 min
Instructor: S. D'Agostino

Answer all questions on the scantron sheet provided.

No aids permitted except for a non-programmable calculator.

Each question is worth 1 mark. Total number of marks: 50.

ANSWERS

1. The mass of Star A is $5M_\odot$, the mass of Star B is $4M_\odot$, and the mass of Star C is $3M_\odot$. The star with the longest lifetime on the main sequence is

   (a) Star A.

   (b) Star B.

   (c) * Star C.

   (d) [There is not enough information.]

2. Very massive, hot stars are positioned in the _____ part of the H-R diagram.

   (a) * upper left

   (b) upper right

   (c) lower left

   (d) lower right

3. Young, luminous stars are

   (a) frequently harassed by annoying paparazzi.

   (b) * typically surrounded by clouds of gas and dust.

   (c) typically found in the intergalactic medium.

   (d) typically found near short-period pulsars.

4. Reflection nebulae appear

   (a) blurry, because astronomers who observe them tend to drink Molson Canadian more often than Blue Light.

   (b) shiny, because they contain a high density of flakes of dust that have been coated with nearly-pure metals.

   (c) red, because they scatter red light more effectively than blue light.

   (d) * blue, because they scatter blue light more effectively than red light.

5. Dark nebulae appear dark because they contain a large amount of

   (a) dark matter.

   (b) * dust.

   (c) nebulinos.

   (d) helium.

6. Emission nebulae appear

   (a) yellow, because they emit a significant amount of yellow electromagnetic radiation.

   (b) blue, because they emit a significant amount of blue and ultraviolet electromagnetic radiation.

   (c) * red, because electrons recombine with protons and then make transitions to lower energy levels, emitting red light in the process.

   (d) dark, because they contain a significant amount of dark matter that can be detected using CCDs attached to radio telescopes.

7. Giant molecular clouds are relatively cool because

   (a) they are in cooler parts of the galaxy.

   (b) they have high solar-type winds, which cool them effectively, much like an air-conditioner.

   (c) they are near black holes, which absorb a lot of heat.

   (d) * they contain a lot of dust, which blocks starlight from reaching into the core of the cloud.

8. Giant molecular clouds contain clumps, which contract due to their own gravity, and in the process

   (a) electromagnetic radiation is converted to nuclear energy.

   (b) nuclear energy is converted to ultraviolet radiation.

   (c) infrared radiation is converted to thermal energy.

   (d) * gravitational potential energy is converted to thermal energy.

9. As a clump of gas contracts to form a protostar, its core heats up. If the core temperature reaches about _____ then fusion of hydrogen into helium begins, and the protostar becomes a main sequence star.

   (a) 100,000 degrees K

   (b) 1 million degrees K

   (c) * 10 million degrees K

   (d) 100 million degrees K

10. The protostar phase of a star's life is

    (a) the end-stage in the life of a low-mass star.

    (b) the end-stage in the life of a high-mass star.

    (c) the main-sequence stage in the life of a low-mass star.

    (d) the main-sequence stage in the life of a high-mass star.

    (e) * [None of the above.]

11. A very low-mass star that never gets hot enough for hydrogen fusion to take place is called a

    (a) loser star.

    (b) * brown dwarf.

    (c) white dwarf.

    (d) black dwarf.

    (e) red dwarf.

12. The proton-proton chain

    (a) should never be broken, according to Fleetwood Mac.

    (b) holds up swings in intergalactic playgrounds.

    (c) is the main way in which high-mass stars convert nuclear potential energy to luminous energy.

    (d) * is the main way in which low-mass stars convert nuclear potential energy to luminous energy.

13. The primary net result of Hydrogen fusion in the core of a star is that

    (a) * four protons are fused into one Helium nucleus and energy is released.

    (b) four neutrons are fused into one Helium nucleus and energy is released.

    (c) four protons are fused into one Helium nucleus and energy is absorbed.

    (d) four neutrons are fused into one Helium nucleus and energy is absorbed.

14. The details of the evolution of a main-sequence star depend primarily on the star's

    (a) friends in the Galactic Senate.

    (b) * mass.

    (c) colour.

    (d) distance from the Earth.

15. Low-mass stars typically have

    (a) * low luminosity.
    (b) high luminosity.
    (c) a wide range of luminosities.
    (d) [Luminosity and mass are not related.]

16. High-mass stars fuse hydrogen into helium primarily through the

    (a) proton-proton chain.
    (b) * CNO cycle.
    (c) Krebs cycle.
    (d) HH fusion mechanism.

17. A planetary nebula

    (a) is a small cloud of gas and dust around a gas giant planet.
    (b) is rarely found around a gas giant planet, because gas giants usually have rings instead.
    (c) is the material in an accretion disk that falls into a black hole.
    (d) * is the stellar material ejected when the core of a medium-sized star collapses into a white dwarf.

18. The core of a white dwarf consists mainly of

    (a) hydrogen and helium, with a smattering of heavy elements.
    (b) an iron core, with concentric rings of lighter elements.
    (c) primarily neutrons, covered by a thin layer of heavy elements.
    (d) * carbon and oxygen.

19. White dwarfs produce light mainly through the

    (a) proton-proton chain.
    (b) CNO cycle.
    (c) Krebs cycle.
    (d) HH fusion mechanism.
    (e) * [None of the above.]

20. Red dwarfs

    (a) are among the hottest of stars.
    (b) are much hotter than white dwarfs.
    (c) * are relatively cool compared to average stars.
    (d) have a wide variety of surface temperatures, some very hot and others not as hot.

21. White dwarfs typically

    (a) are more massive than the Sun, and also more dense than the Sun.
    (b) are less massive than the Sun, and also less dense than the Sun.
    (c) * have a range of masses, but are definitely more dense than the Sun.
    (d) have a range of masses, but are definitely less dense than the Sun.

22. In a normal main-sequence star, the temperature and pressure

    (a) are approximately constant, although very high, throughout the star.
    (b) decrease towards the centre of the star.
    (c) * increase towards the centre of the star.
    (d) [Temperature and pressure are not related in a normal main-sequence star.]

23. The "pressure-temperature thermostat"

    (a) is a constant source of conflict between me and my wife (she always wants it down, I want it up).
    (b) decreases the pressure.
    (c) increases the pressure.
    (d) * maintains a star in hydrostatic equilibrium.

24. Degenerate matter

    (a) results when a star dies and decomposes.
    (b) is present at the core of all stars.
    (c) * is present in white dwarfs and neutron stars.
    (d) is present in brown dwarfs and red dwarfs.

25. The Chandrasekhar limit is

    (a) the maximum number of pastries Mrs. Chandrasekhar allowed Mr. Chandrasekhar to eat after dinner.
    (b) * the maximum mass for a degenerate stellar object.
    (c) the maximum density for a degenerate stellar object.
    (d) the maximum temperature for a degenerate stellar object.

26. The size of a white dwarfs is approximately

    (a) half the size of the Sun.
    (b) the size of Jupiter.
    (c) * the size of the Earth.
    (d) 10 km in diameter.

27. White dwarfs dim and eventually become

    (a) red dwarfs.

    (b) brown dwarfs.

    (c) * black dwarfs.

    (d) black holes.

28. A type Ia supernova occurs because of

    (a) the core collapse of a medium-mass star.

    (b) the core collapse of a high-mass star.

    (c) * matter from a nearby star falling onto the surface of a white dwarf, becoming compressed and heated, and eventually resulting in an explosion.

    (d) matter from a nearby star falling onto the surface of a neutron star, becoming compressed and heated, and eventually resulting in an explosion.

29. A type II supernova occurs because of

    (a) the core collapse of a medium-mass star.

    (b) * the core collapse of a high-mass star.

    (c) matter from a nearby star falling onto the surface of a white dwarf, becoming compressed and heated, and eventually resulting in an explosion.

    (d) matter from a nearby star falling onto the surface of a neutron star, becoming compressed and heated, and eventually resulting in an explosion.

30. While a star is on the main sequence, its luminosity

    (a) * gradually increases.

    (b) gradually decreases.

    (c) fluctuates wildly, depending on its mood.

    (d) fluctuates wildly, depending on its sunspot cycle.

31. When the Sun is in its first red giant phase, its size will be about the same as

    (a) * the orbit of Mercury.

    (b) the orbit of Venus.

    (c) the orbit of Earth.

    (d) the orbit of Mars.

    (e) the orbit of Jupiter.

32. When the Sun is in its second red giant phase, its size will be about the same as

    (a) the orbit of Mercury.
    (b) the orbit of Venus.
    (c) the orbit of Earth.
    (d) * the orbit of Mars.
    (e) the orbit of Jupiter.

33. The spin rate of a pulsar

    (a) increases as time passes.
    (b) * decreases as time passes.
    (c) remains constant as time passes.
    (d) [Pulsars do not spin.]

34. The Schwarzschild radius is

    (a) the smallest possible radius of a white dwarf.
    (b) the smallest possible radius of a neutron star.
    (c) the radius of the region around a neutron star within which X-ray bursts occur.
    (d) * the radius of the region around a black hole within which not even light can escape.

35. Neutron stars with masses greater than about 3 solar masses do not exist because neutron degeneracy pressure is not strong enough to balance gravity, and so

    (a) the neutron star explodes into a Type II supernova.
    (b) the neutron star explodes into a Type Ib supernova.
    (c) * the neutron star collapses into a black hole.
    (d) [No star is massive enough to produce such a massive stellar remnant.]

36. The Crab Nebula is

    (a) the newest dish on the menu at Sammy's Seafood Shack.
    (b) a planetary nebula.
    (c) a dark nebular.
    (d) * a supernova remnant.

37. The first astronomer to observe that the Milky Way consists of a very large number of faint stars was

    (a) Tycho Brahe.

    (b) * Galileo Galilei.

    (c) Johannes Kepler.

    (d) Buzz Lightyear.

    (e) Isaac Newton.

38. The basic idea behind the general theory of relativity (Einstein's theory of gravity) is that

    (a) inert matter has no energy, and energy doesn't matter.

    (b) matter and energy cause space to curve.

    (c) * matter and energy cause spacetime to curve.

    (d) matter and energy can be converted into each other according to $E = mc^2$.

39. Gravitational redshift refers to

    (a) * the shifting of the wavelength of light towards longer wavelengths when light moves away from a strong source of gravity such as a star.

    (b) the shifting of the wavelength of light towards shorter wavelengths when light moves away from a strong source of gravity such as a star.

    (c) the shifting of the wavelength of light towards longer wavelengths when the light is emitted by a star moving away from us.

    (d) the shifting of the wavelength of light towards shorter wavelengths when the light is emitted by a star moving away from us.

    (e) the bending of the path of light as it passes close to a strong source of gravity such as a star.

40. Harlow Shapley determined our location in the Milky Way by measuring certain distances using the method of _____ pioneered by Henrietta Swan Leavitt.

    (a) * Cepheid variables

    (b) RR Lyrae variables

    (c) Mira variables

    (d) Type Ia supernovae

41. Leavitt and Shapley performed their work to determine our location in the Milky Way in

    (a) the 3rd century BC.
    (b) the 1600s.
    (c) the 1700s.
    (d) the 1800s.
    (e) * the 1900s.

42. The diameter of the Milky Way is approximately

    (a) 100 light years
    (b) 1,000 light years
    (c) 10,000 light years
    (d) * 100,000 light years
    (e) 1,000,000 light years

43. When a spinning star contracts, its spin rate

    (a) * increases.
    (b) decreases.
    (c) remains constant.
    (d) [Stars don't spin.]

44. Population I stars have a _____ concentration of heavy elements than Population II stars.

    (a) lower
    (b) * higher
    (c) [The concentrations are about equal.]
    (d) [Neither population has stars that contain any heavy elements.]

45. The number of stars in the Milky Way is approximately

    (a) 100,000.
    (b) 1,000,000.
    (c) 10,000,000.
    (d) * [The actual number is much greater than any of the numbers listed here.]

46. The Milky Way contains

    (a) * stars, gas, and dust, among other things.

    (b) stars and gas, but no dust.

    (c) stars and dust, but no gas.

    (d) stars and other things, but no gas and no dust.

47. Recent discoveries of dark matter and dark energy have suggested that the composition of the universe that is ordinary matter is about

    (a) * 5%.

    (b) 25%.

    (c) 45%.

    (d) 85%.

48. "Rotation curves" for stars at various positions in the Milky Way, first measured by Vera Rubin, do not match observed luminous matter in the galaxy. This is strong evidence for the presence of

    (a) the LMC gyre, which contains an enormous number of discarded toasters and TV sets.

    (b) * dark matter in the Milky Way.

    (c) a giant black hole at the centre of the Milky Way.

    (d) an enormous number of neutrinos streaming through the Milky Way.

49. The compression waves in the Milky Way's spiral arms move around the galaxy

    (a) * more slowly than stars.

    (b) more rapidly than stars.

    (c) at about the same speed as stars.

    (d) [Compression waves in the Milky Way's spiral arms don't move.]

50. The average distance between stars in the Milky Way is about

    (a) * a few light years.

    (b) a few hundred light years.

    (c) a few thousand light years.

    (d) a few million light years.