Astronomy Test - 2021 Fall Invitational Team Name_____

Total score ____/124

You have 50 minutes to complete the test. All multiple choice questions are worth 2 pts, free response questions have point values indicated. Tiebreaker questions marked with *, in event of a tie the correctness of each of these questions will be compared in the order they appear on the test.

Multiple Choice (20 pts)

1. What is the difference between the Morgan-Keenan C system of classifying carbon stars compared to the revised Morgan-Keenan classification?
    a. it failed to correlate to temperature measurements based on infrared,
    b. originally being two-dimensional it was soon enhanced by suffixes, CH, CN, j and other features making it impractical for en-masse analyses of foreign galaxies' carbon star populations,
    c. and it gradually occurred that the old R and N stars actually were two distinct types of carbon stars, having real astrophysical significance
    d. ^ fixed those things

2. What is Kepler's second law?
    a. A line that connects a planet to the sun sweeps out equal areas in equal times.
    b. The square of the period of any planet is proportional to the cube of the semimajor axis of its orbit.
    c. All planets move in elliptical orbits, with the sun at one focus.
    d. Two objects attracted to each other will feel the same gravitational force.
    e. Mass cannot be created nor destroyed.

3. What could happen when a white dwarf exceeds the Chandrasekhar limit? Select all that apply.
    a. Collapses into a neutron star.
    b. Slowly becomes dimmer and fades away
    c. Becomes a black hole
    d. Form brown dwarfs
    e. White dwarfs cannot exceed the Chandrasekhar limit

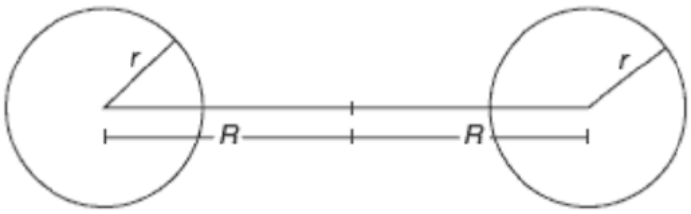
4. What temperature do protostars need to reach before it becomes a main sequence star?
    a. 9 million Kelvin
    b. 10 million Kelvin
    c. 12 million Kelvin
    d. 15 million Kelvin
    e. 20 million Kelvin

5. Which of the following are binary systems that involve mass transfer from a low-mass star to a white dwarf?
    a. Mira variables
    b. Herbig-Haro objects
    c. T Tauri variables
    d. Magnetic cataclysmic variables
    e. RR Lyrae variables

6. Under what spectral class(es) can RR Lyrae variables fall into? Select all that apply.
    a. O
    b. B
    c. A
    d. F
    e. G
    f. K
    g. M

7. How long does the period for RR Lyrae variables last?
    a. 2 years
    b. 3 months
    c. 1 day
    d. 30 days
    e. None of the above

Use the following image to complete questions 8 and 9



Two stars, each of mass M, form a binary system. The stars orbit about a point a distance R from the center of each star, as shown in the diagram above. The stars themselves each have radius r.

8. What is the force each star exerts on the other?

a. $G\frac{M^2}{(2r+2R)^2}$

b. $G\frac{M^2}{(R+r)^2}$

c. $G\frac{M^2}{R^2}$

d. $G\frac{M^2}{4R^2}$

e. $G\frac{M^2}{2R^2}$

9. In terms of each star's tangential speed v, what is the centripetal acceleration of each star?

a. $\frac{v^2}{2R}$

b. $\frac{v^2}{(r+R)}$

c. $\frac{v^2}{2(r+R)}$

d. $\frac{v^2}{2r}$

e. $\frac{v^2}{R}$

10. During which phase does a star become classified as an RR Lyrae star?
    a. Red Supergiant
    b. Average Star
    c. Red Giant
    d. Massive Star

Identification (#11-20) (20 pts)

Identify the Deep Space Objects in the images shown on the board

11.	16.
12.	17.

13.	18.
14.	19.
15.	20.

Follow-Up Questions (32 pts)- these questions relate to the above Identification section, so use your answers from above to answers the following questions.

21. Use your answer from Identification 11
    a. Flares of light have been detected from this DSO. What wavelength of light are they in?

    b. Why can other flares not be detected?

22. Use your answer from Identification 12
    a. What class of protostar is shown in the image above?

    b. What causes the astrophysical jets in the image?

23. Use your answer from Identification 13
    a. This DSO, in which helium burning cedes and the helium shell runs out of fuel, is in which AGB phase?

    b. This DSO leaves a tail behind, considered to be caused by a bow shock. What will this DSO's bow shock eventually evolve into?

24. Use your answer from Identification 14
    a. What kind of radiation is being emitted from the core of this DSO?

25. Use your answer from Identification 15
    a. Shocks have been detected in the DSO above. What are they caused by?

    b. What are the three types of shocks in this DSO?

    c. What is the green coloration in this DSO thought to be caused by?

26. Use your answer from Identification 18
    a. Classify the DSO and explain.

    b. Identify any secondary objects found in this DSO.

27. Use your answer from Identification 19
    a. What type of nebula is this DSO?

    b. Why is the DSO classified this way?

28. Use your answer from Identification 20
    a. The DSO in 20 is also classified as what? Explain.

    b. What color is the DSO from 20?

Short Response (#29-44)

29. (2pts) How are type Ia supernovae used to determine the distance to a galaxy?

30 . (2 pts) What happens if the critical temperature of a protostar is never reached?

31. (4 pts) Why does it seem like Mira variables change their period?

32. (4 pts) Why is the name “planetary nebula” a misnomer? Why were they named this way?

33. (3 pts) If a star has a temperature of 25000 K and has 10,000 times the luminosity of the Sun, what is its radius compared to the Sun’s?

34. (3 pts) A type Ia supernova was seen in M101 in 2011. The brightest apparent magnitude it attained was +10. What is the distance to M101 in light years?

35. (3pts) A binary system consists of two stars, one of 10 solar masses and the other of 6 solar masses. If it takes one star 2 years to orbit their common center of mass, what is the semi-major axis of this star’s orbit in AU?

36. (4 pts) What two types of stars make up AR Scorpii?

37. (4 pts) You're standing on Earth staring at the fictional star Miriad X5. You know that this star has an apparent magnitude of .14. You know that this star has an absolute magnitude of -4.2. How far from the Earth (in pc) is the star?

38. (2 pts) A star shows relatively strong signs of absorption lines of neutral helium. Based on this assumption, what spectral class is this star?

39. (4 pts) Using the basic assumption of Kepler's third law, you want to calculate the orbital period of a body. You know that the body sits at 5.2 au away from the star it orbits. What is the orbital period of this body in days?

40. (2 pts) About how long do stars stay in the t-tauri phase before it becomes a true star?

41. (4 pts) What are Cepheid variables and how are they different from RR lyrae variables?

42. (4 pts) How do recurrent novas differ from other novas and how many are known to exist?

43. (4 pts) How are Herbig-Haro objects formed and what do they allow astronomers to do?

44. (3 pts) Two stars are the same distance from us and have the same surface temperature of 10000 K. Star A has a diameter of 140000 km and Star B has a diameter of 100000 km. How much more luminous is star A compared to star B?