ASTRONOMY

WAYZATA INVITATIONAL 2011

by Michael Huberty

Team Number _____

School Name _____

Total Points _____

You may tear this sheet off of the rest of the test to use as your answer sheet. Please make sure that you print legibly on this sheet. Only answers recorded on this page will be scored. If the question has multiple choices, circle the letter of the best choice. At the end of the event, please turn in the Answer Sheet and the Test. Good Luck!!!!!!!!!

1. A B C D

2. A B C D

3. A B C D

4. _____

5. A B C D

6. A B C D

7. A B C D E

8. A B C D

9. A B C D

10. _____

11. A B C D E

12. _____

13. A B

14. A B C

15. A B C D E

16. A B C D

17. _____

18. A B C D

19. A B C D

20. _____

21. A B C D

22. A B C D

23. A B C D

24. _____

25. A B C D

26. A B C D

27. A B C D

28. A B C D

29. _____

30. A B C D E F G

31. _____

32. _____

33. A B C D

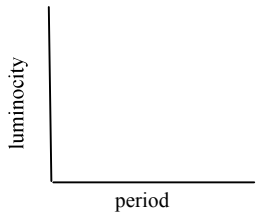
34. _____

35. _____

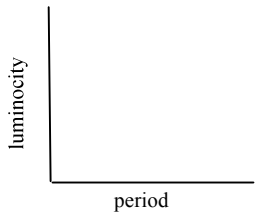
36. A B C D

37. A B C D

38.



39.



40. _____

41. A B C D

42. A B C D

43. _____

44. _____

45. A B C D

46. _____

47. _____

48. A B C D

49. _____

50. _____

_____

51. _____ names: _____

FIGURE 1

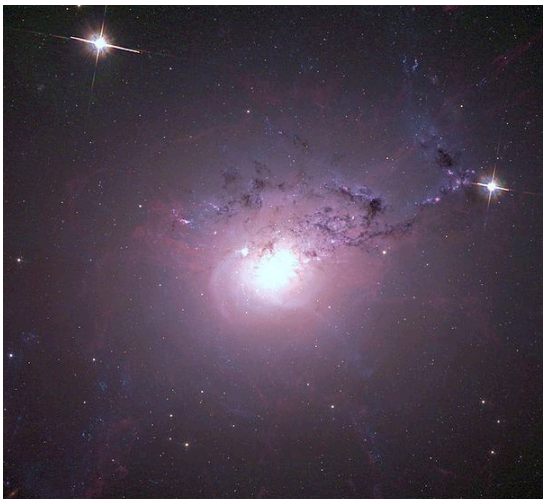


FIGURE 2

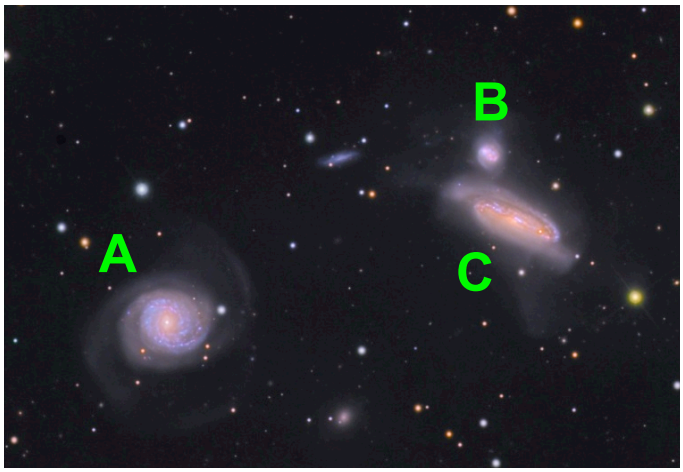


FIGURE 3

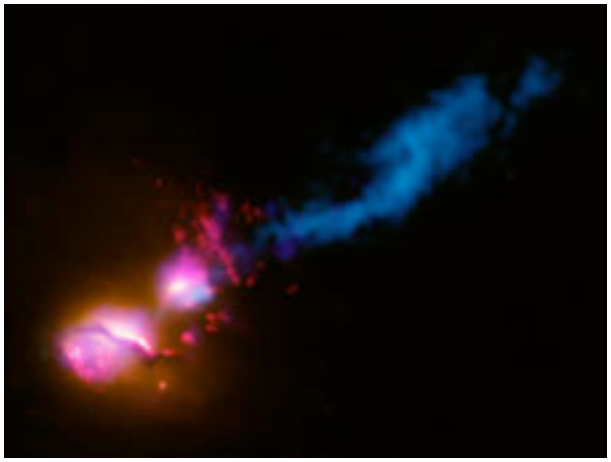


FIGURE 4

FIGURE 5

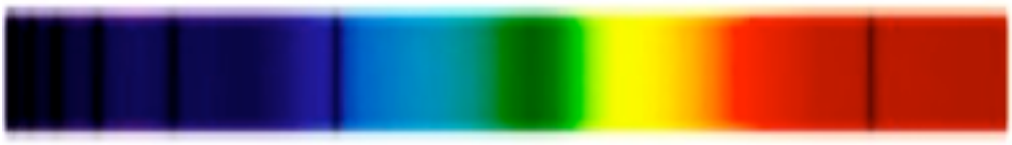


FIGURE 6

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1. Which star is described as the "mysterious fading star"?
   A. Perseus A
   B. Cen A
   C. Epsilon Aurigae
   D. SN 1996cr

2. How often does the "mysterious fading star" fade?
   A. every 16 hours
   B. every 72 days
   C. every 11 years
   D. every 27 years

3. Why do astronomers think the "mysterious fading star" fades?
   A. It is eclipsed by another object.
   B. It is an RR Lyrae variable.
   C. It is a pulsar.
   D. It is a quasar.

4. In which constellation is the "mysterious fading star" located?

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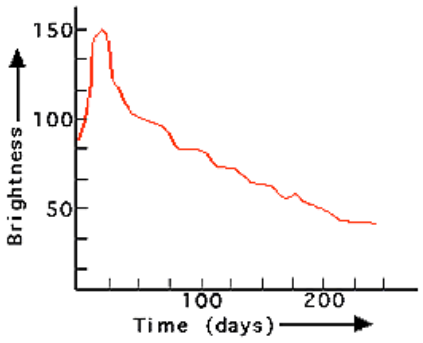
5. Quasars have very large redshifts due to
   A. their high energies
   B. the expansion of the universe
   C. their pulsations
   D. their high velocities

6. The graph at right shows the light curve of
   A. a supernova
   B. an Cepheid star
   C. an RR Lyrae Variable star
   D. a long period variable star



7. The current approximation of the number of variable stars within the Milky Way region is
   A. < 1,000
   B. 1,001 – 5,000
   C. 5,001 - 15,000
   D. 15,001 – 30,000
   E. > 30,000

8. In Figure 1, synchrotron radiation is being ejected from
   A. an active galactic nucleus
   B. a galaxy cluster
   C. a globular cluster
   D. a Cepheid star

Use Figure 2 to answer questions 9 through 11 regarding Caldwell 24.

9. What is Caldwell 24?
   A. quasars
   B. supernovae
   C. globular clusters
   D. galaxies

10. In which constellation is Caldwell 24 located?

11. How far from Earth is Caldwell 24?
   A. 47 million light-years
   B. 237 million light-years
   C. 3 miles
   D. 3,310 light years
   E. 12 million light-years

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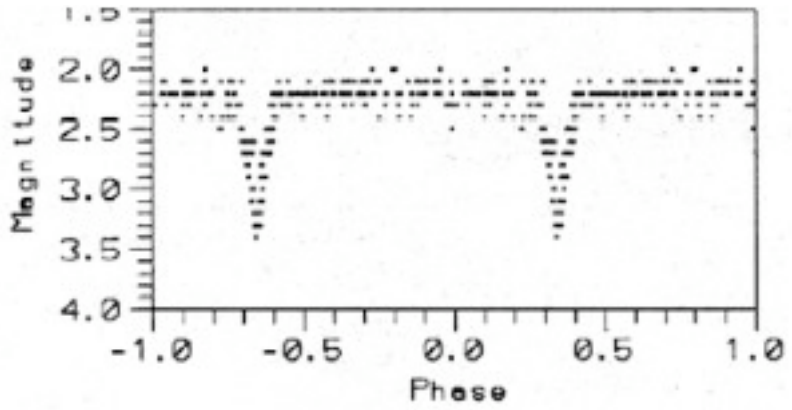
12. Two stars, call them Star α and Star β, make up an eclipsing binary star system. The apparent magnitude of the system is plotted below as a function of time. Assume that Star α and is completely eclipsed by Star β. What is the apparent magnitude of Star β?



13. Initially, Star δ had an absolute magnitude of +5 and Star ε had an absolute magnitude of –4. Later, the absolute magnitude of Star δ decreased to +9 and the absolute magnitude of Star ε decreased to –5. For which star was the change in luminosity greater?
   A. Star δ
   B. Star ε

Use Figure 3 to help with questions 14 through 17 regarding NGC 7771.

14. Which galaxy labeled in Figure 3 is NGC 7771?
    A. galaxy A
    B. galaxy B
    C. galaxy C

15. What type of galaxy is NGC 7771?
    A. spiral
    B. barred spiral
    C. elliptical
    D. ring
    E. irregular

16. What will happen to the three galaxies in Figure 3 over hundreds of millions of years?
    A. They will merge into one very large galaxy.
    B. They will remain in the same configuration.
    C. They will more further away from each other.
    D. We cannot predict what they will do.

17. In what constellation is NGC 7771 located?

Use Figure 4 to answer questions 18 through 20.

18. The lower-left "death star" galaxy in Figure 4 is blasting a nearby galaxy with a powerful jet. What is the source of the jet of energy in the "death star" galaxy?
    A. black hole
    B. quasar
    C. Cephied variable
    D. globular cluster

19. What is the designation of the galaxies in Figure 4?
    A. 3C321
    B. 1E 0657-56
    C. MACSJ0717.5+3745
    D. JKCS041

20. In which constellation are the galaxies in Figure 4 located?

Use Figure 5 to answer questions 21 through 24.

21. Figure 5 is an image of
    E. Centaurus A
    F. Stephan's Quintet
    G. the Bullet Cluster
    H. Perseus A

22. The object in Figure 5 is evidence of
    E. black holes
    F. space-time
    G. dark energy
    H. dark matter

23. The pink region in Figure 5 is
    A. X-rays of hot gas
    B. gamma radiation
    C. pink energy
    D. dark matter

24. In which constellation is the object in Figure 5 located?

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25. In a Cepheid star:
    A. as the radius decreases, the temperature decreases and the opacity increases.
    B. as the radius decreases, the temperature and opacity increase.
    C. as the radius decreases, the temperature increases and the opacity decreases.
    D. as the radius decreases, the temperature and opacity decrease.

26. In a Cepheid star:
    A. as the radius increases, Helium recombines and pressure drops.
    B. as the radius increases, Helium ionizes and the pressure drops.
    C. as the radius increases, Helium recombines and the pressure increases.
    D. as the radius increases, Helium ionizes and the pressure increases.

27. Approximately what percentage of all stars are binary or multiple versus a solo star like our own.
    A. 20%
    B. 40%
    C. 60%
    D. 80%

28. Cepheid stars give off ____ times as much light as RR Lyraes
    A. 0.1
    B. 10
    C. 100
    D. 1,000

29. Intrinsic variable stars can be divided into Eruptive (Cataclysmic stars) and _____?

30. The causes of stellar variablilty is/are:

    I. Physical changes within the star
    II. Earths atmospheric interference
    III. Geometrical alignment

    A. I only
    B. II only
    C. III only
    D. I and II only
    E. II and III only
    F. I and III only
    G. I, II and III

31. A star has an apparent magnitude 3.0 and distance 100 pc. What is its absolute magnitude?

32. A star has an apparent magnitude 9.0 and absolute magnitude 2.0. How far away is it rounded to the nearest whole pc? (Do not use the unit in your answer)

33. The following data was recorded after observing a variable star every other night for a period of time:

Date	Star Brightness
1-Apr	9.1
3-Apr	9.3
5-Apr	9.8
7-Apr	9.9
9-Apr	9.7
11-Apr	9.9
13-Apr	9.9
15-Apr	9.7
17-Apr	9.1
19-Apr	8.8
21-Apr	8.8
23-Apr	8.3
25-Apr	8.6
27-Apr	9.0
29-Apr	9.1
1-May	9.2
3-May	9.6
5-May	9.9
7-May	9.6
9-May	9.7

    What is the period of the variable star?
    A. 8 Days
    B. 14 days
    C. 17 days
    D. 29 days

34. A main sequence star and has an apparent magnitude of + 20. The visible absorption spectrum for the star is shown in Figure 6. How far away is it from the observer (in pcs)?

Use Figure 7 (below) to answer questions 35 through 37.

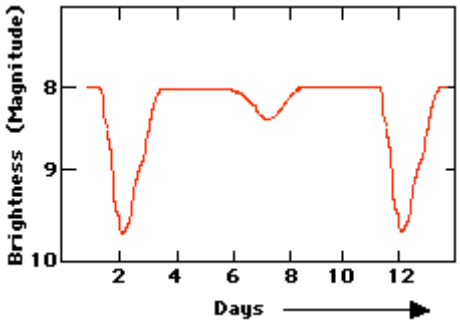


FIGURE 7

35. What is the approximate period of the star with light curve shown in Figure 7?

36. Figure 7 shows a distinctive light curve for an eclipsing binary with stars of
    A. unequal diameter/brightness
    B. equal diameter/brightness
    C. equal diameter but unequal brightness
    D. equal brightness but unequal diameter

37. Figure 7 is characteristic of a light curve produced by two stars with
    A. the same surface temperature and same brightness.
    B. different surface temperatures but the same brightness.
    C. different surface temperatures and different brightness.
    D. the same surface temperatures but different brightness.

38. Sketch the period-luminosity graph for Cepheid variables.

39. Sketch the period-luminosity graph for RR Lyrae variables.

40. According to the period-luminosity law for Cepheid variables, the longer the period of the Cepheid variable, the _____ is the Cepheid.

41. Epsilon Aurigae is traditionally known as all of the following names EXCEPT
    A. Al Anz
    B. Almaaz
    C. Capella
    D. Haldus

42 On the Hertzsprung-Russell Diagram, RR Lyrae variables are located:
    A. above the Giants.
    B. below the Giants.
    C. left of the Giants.
    D. right of the Giants.

43. A star is observed to have a parallax of 0.25 arc seconds. What is the star's distance in meters?

44. During a Type Ia supernova explosion, a white dwarf star explodes when it pulls too much material from a companion star onto itself. When the white dwarf's mass exceeds _____ times the Sun's mass, the white dwarf becomes unstable and explodes.

45. Star A is twice as far away as Star B. The parallax of A is
    A. half that of Star B.
    B. the same as Star B.
    C. twice that of Star B.
    D. four times that of Star B.

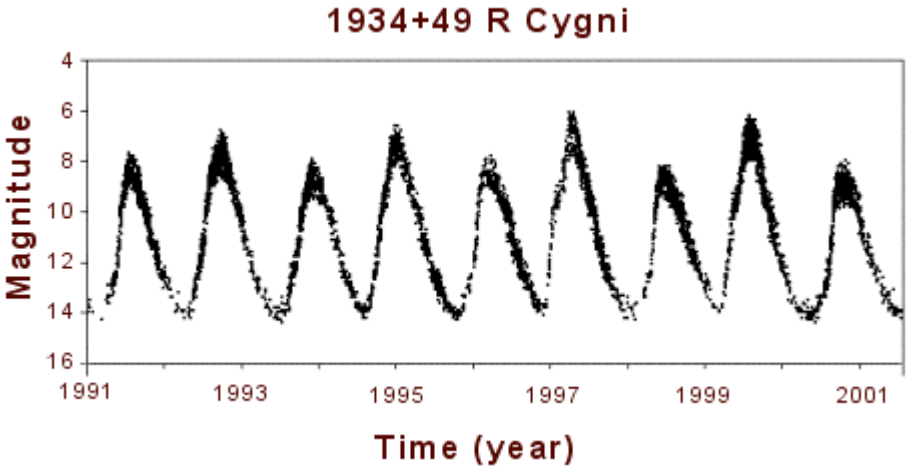
46. How much brighter is a -2 magnitude star than a +2 magnitude star?

47. RR Lyrae variable stars are typically _____ giant stars? (fill in the blank with a color)

48. Variable stars are stars in which the _____ changes over time.
    A. Size
    B. Color
    C. Shape
    D. brightness

49. A planet orbits the Sun at 3 AU. How long (in years) does it take to orbit the Sun? (Hint: Find its period using Kepler's Third Law. The Earth is at 1 AU.) [Used as tie breaker]

50. Describe the spectra of R Cygni (see figure below). What do you see happening with the peaks?



51. How many naked eye supernova have been observed from the Earth in the past 500 years? Naming as many as you can will be used to break any ties.