ASTRONOMY

MINNESOTA REGIONS 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 problem 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   E

2. A   B   C   D   E

3. A   B   C   D

4. _____

5. A   B   C   D   E

6. _____

7. _____

8. _____

9.   A   B   C   D   E

10. A   B   C   D

11. _____

12. A   B   C   D   E

13. A   B

14. X   Y

15. _____

16. X   Y

17. _____

18. A   B   C   D   E

19. A   B   C   D   E

20. _____

21. A   B   C   D   E

22. A   B   C   D

23. _____

24. _____

25. A   B   C

26. A   B   C

27. _____

28. A   B   C

29. _____

30. A   B   C   D   E   F

31. A   B   C   D   E   F

32. A   B   C   D   E   F

33. A   B   C   D   E   F

34. A   B

35. _____

36. A   C

37. _____

38. A   F

39. _____

40. _____

41. B   D

42. _____

43. _____

44. A   B   C   D

45. _____

46. _____

47. _____

48. _____

49. _____

50. _____

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Use Figure 1 to answer problems 1 through 4.

1. Figure 1 is an image of
    A. NGC 7771
    B. NGC 1275
    C. NGC 1068
    D. NGC 4603
    E. NGC 2623

2. What type of galaxy is Figure 1?
    A. elliptical
    B. irregular
    C. lenticular
    D. barred spiral
    E. ring

3. What is at the center of the galaxy in Figure 1?
    A. black hole
    B. Cepheid
    C. X-ray binary
    D. globular cluster

4. In which constellation is the object in Figure 1 located?

5. The most distant galaxy cluster found so far is designated
    A. Epsilon Aurigae
    B. JKCS041
    C. SN 2006gy
    D. H 2356-309
    E. MACSJ0717.5+3745

6. How far away from Earth is the galaxy cluster in problem 5 (measured in light years)?

7. How many years has it taken the light from the galaxy cluster in problem 5 to reach Earth?

8. In which constellation is the galaxy cluster in problem 5 located?

Use Figure 2 to answer problem 9 through 11.

9. Figure 2 is an image of
    A. NGC 2623
    B. 1E 0657-56
    C. NGC 6240
    D. 3C321
    E. Cen A

10. What does Figure 2 depict?
    A. black holes exploding
    B. RR Lyrae
    C. eclipsing binaries
    D. galaxies merging

11. In which constellation is the object in Figure 2 located?

12. Which of the following is NOT a Seyfert galaxy?
    A. Perseus A
    B. NGC 7771
    C. NGC 7319
    D. NGC 1068
    E. H 2356-309

13. What type of variable star is more common: Cepheid variables or Mira variables?
    A. Cepheid
    B. Mira

Use the following to answer problems 14 through 17:
    Galaxies X and Y appear equally bright in the night sky. When a radio spectra of both galaxies are taken, the 21cm line of galaxy X is twice as wide as that of galaxy Y.

14. Which galaxy has a greater absolute luminosity?

15. For problem 14, how many times greater is the absolute luminosity?

16. According to Hubble's law, which galaxy will have the greater recessional velocity?

17. For problem 16, how many times greater is the recessional velocity?

**Use Figure 3 to answer problems 18 through 20.**

18. Figure 3 is an image of
    A. Stephan's Quintet
    B. Bullet Cluster
    C. SN 2006gy
    D. SN 1996cr
    E. NGC 2623

19. Which galaxy depicted in Figure 3 is not physically associated with the rest?

20. In which constellation is the object in Figure 3 located?

**Use Figure 4 to answer problems 21 through 24.**

21. Figure 4 is an image of
    A. SN 1996cr
    B. Al Anz
    C. NGC 4603
    D. Caldwell 24
    E. Messier 77

22. The distance to the object in Figure 4 has been accurately measured due to the presence of
    A. a supermassive black hole
    B. Type Ia supernovae
    C. AGNs
    D. Cephied variables

23. How far away from Earth is the object in Figure 4 (measured in light years)?

24. In which constellation is the object in Figure 4 located?

25. Cepheid stars have a period of variability that is _____ RR Lyrea variable stars.
    A. greater than
    B. less than
    C. equal to

26. Classical Cepheids have light curves that
    A. increase and decrease in brightness at regular rates.
    B. increase in brightness slowly and then decrease in brightness rapidly.
    C. increase in brightness rapidly and then decrease in brightness slowly.

27. Use the light curve of a Cepheid variable shown below to calculate the distance to a galaxy.
[2 points – This problem will also be used as tie breaker.]
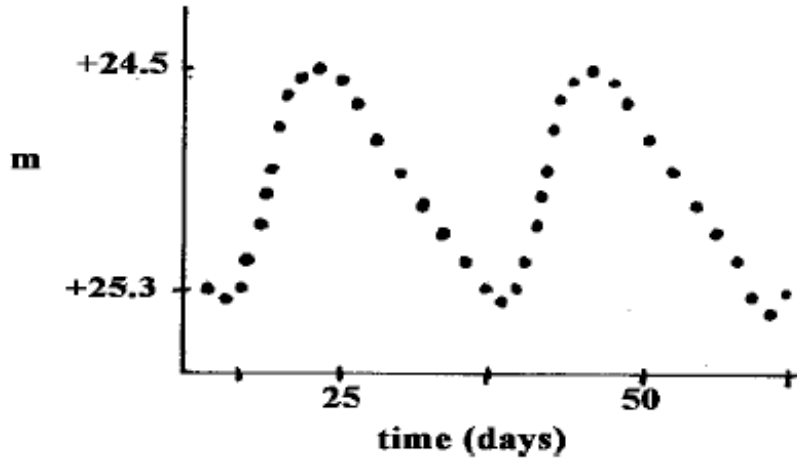
28. A study is conducted of binary star systems in which both members have the same mass and the distance between the two stars is the same for all systems in the study. The relationship between the absolute luminosities and masses of stars in the study is reflected by the graph and function given below.

$$Luminosity = k \cdot Mass^2$$
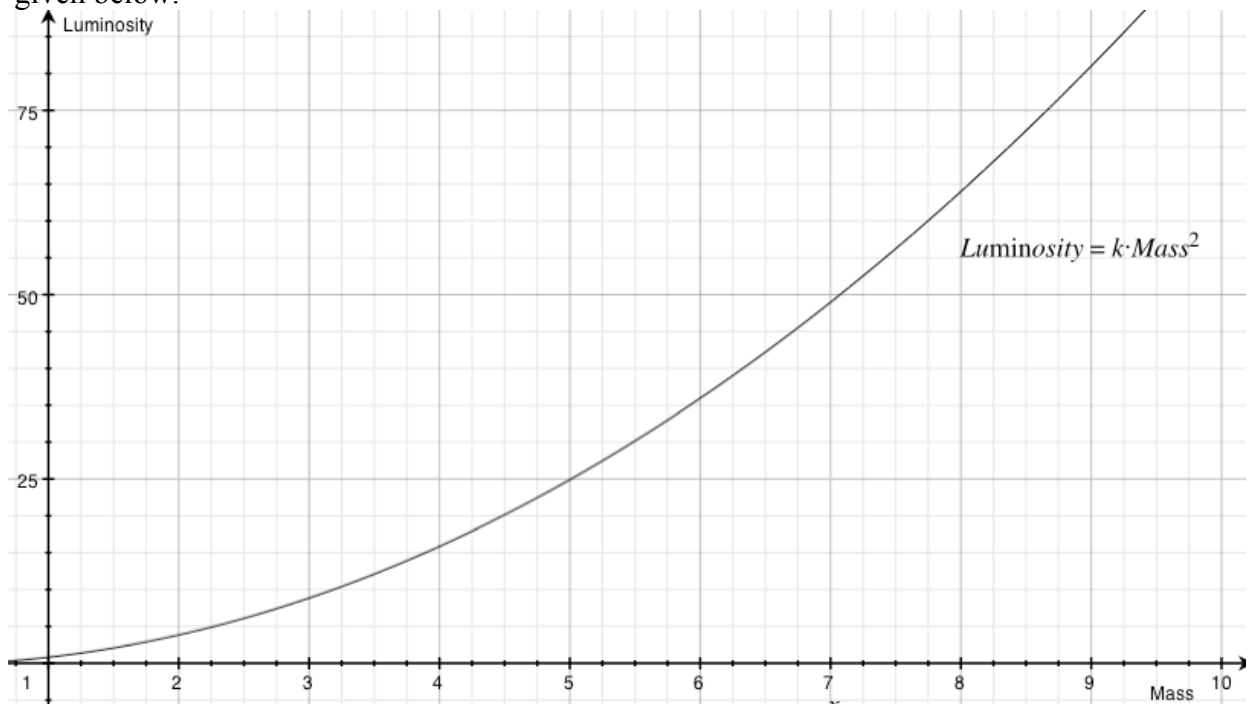
If a plot is made of the absolute luminosity of the binary system as a function of its period, you would expect the direction of the relationship (not necessarily linear) to be
A. positive
B. zero
C. negative

29. A nova that has multiple outbursts is called a _____ nova.

Use the HR diagram below to answer problems 30 through 42.
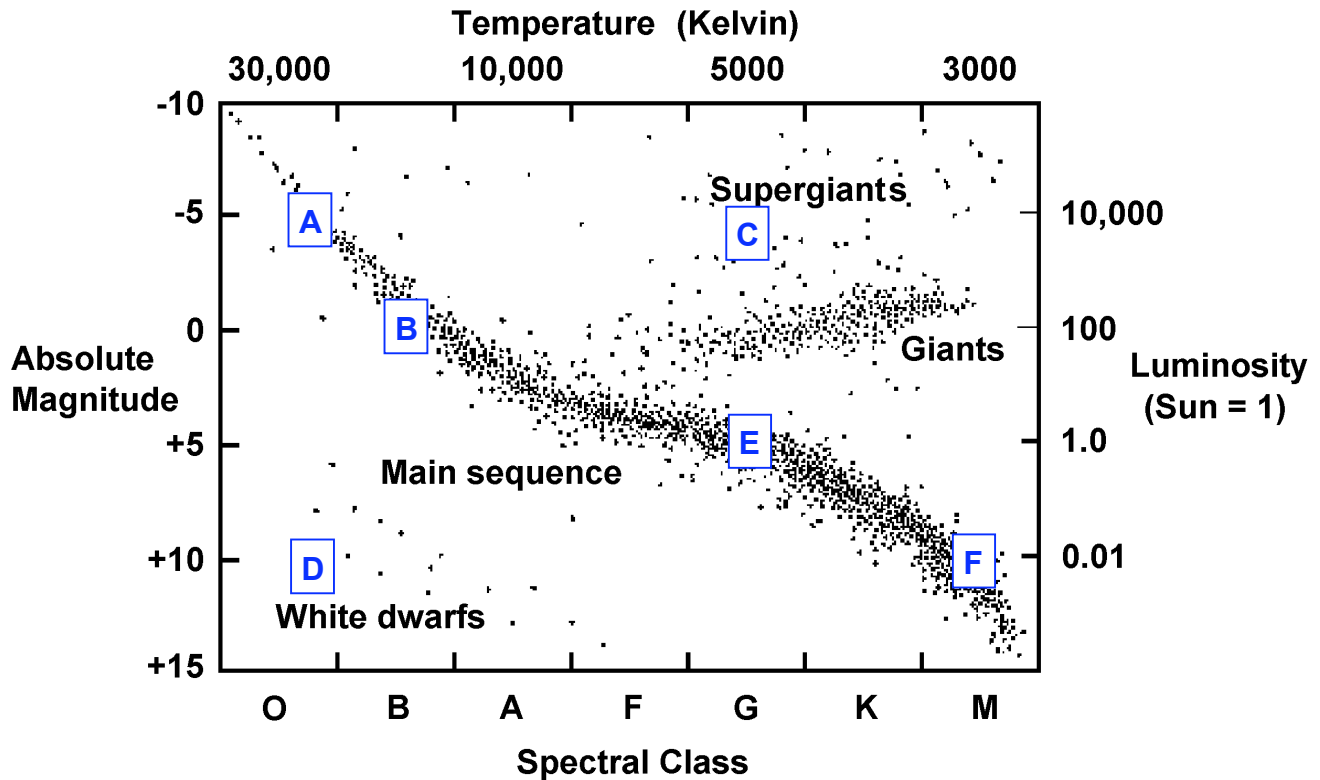
30. Of the stars labeled on the diagram above, which **two** are the two hottest? [2 points]

31. Of the stars labeled on the diagram above, which **two** are the two brightest? [2 points]

32. Of the stars labeled on the diagram above, which one has the largest radius?

33. Of the stars labeled on the diagram above, which is most like our sun?

34. Is star A or B brighter?

35. How many times brighter is the brighter star in problem 34 compared to the dimmer star?

36. Does star A or C radiate more energy per unit area?

37. How many times more energy does the more energetic star radiate in problem 36 compared to the less energetic star?

38. Does star A or F have a larger radius?

39. How many times larger is the radius of the larger star in problem 38 compared to the smaller star?

40. At what wavelength does star E radiate the most energy?

41. If both star B and star D appear equally bright in the night sky, which is farther away from the observer?

42. How many times further away is the far star in problem 41 compared to the near star?

43. What type of star will be left as a Mira variable star evolves?

44 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.

45. Approximately how much longer will our Sun remain on the main sequence?

46. What type of variable star will our Sun become in about 5 billion years?

47. What is the name of the type of variable star where a cloud of dust is believed to periodically obscure the surface of the star?

48. Jupiter has a moon named Io, and they both orbit the Sun at a distance of 5 AU. The Earth orbits the Sun at 1 AU. When Jupiter is closest to Earth, the apparent magnitude of Io as seen from the Earth is 5 magnitudes. How far (in AU) would Io have to be from the Earth in order for it to have an apparent magnitude of 0? [2 points – This problem will also be used as tie breaker.]

49. What is the he most recent observational determination of the Hubble Constant? [2 points]

50. Explain what the Hubble Constant tells us. [3 points – This problem will also be used as tie breaker.]
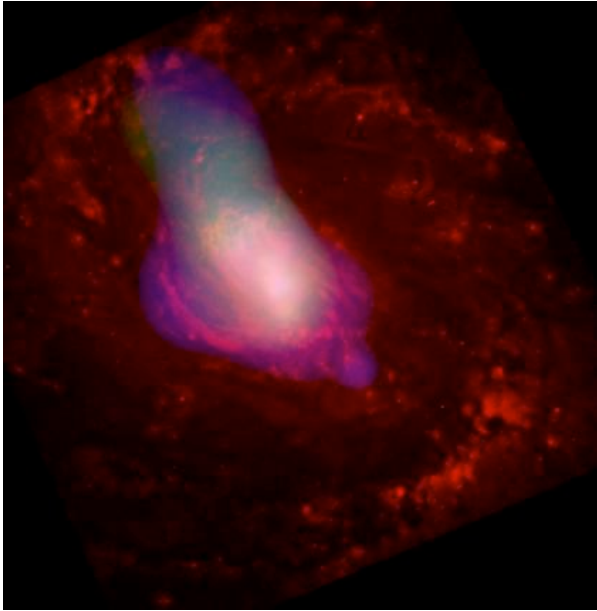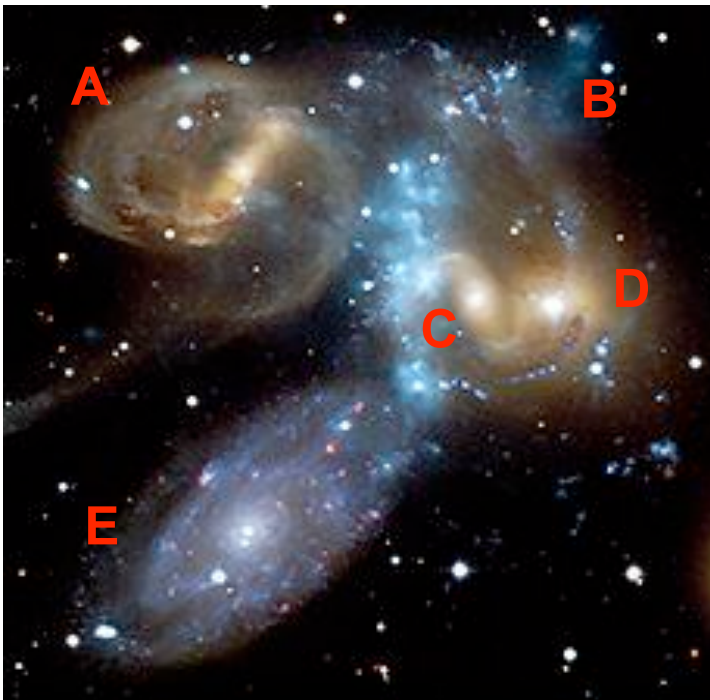
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COLOR IMAGES

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4