NATIONAL SCIENCE OLYMPIAD
ASTRONOMY C DIVISION EVENT
10 MAY 2003
OHIO STATE UNIVERSITY – COLUMBUS, OHIO

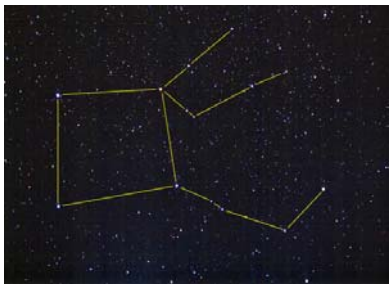
TEAM NUMBER: _____

TEAM NAME: _____

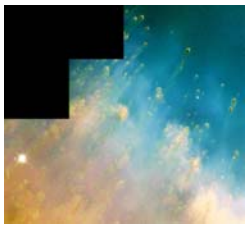
INSTRUCTIONS:

1) **Please turn in ALL materials at the end of the event.**
2) **Do not forget to put your TEAM NAME and NUMBER on both this page and at the top of the Response Page.**
3) **Only answers placed on the Response Page will be counted.**
4) **This event and the answer key will be available on the Wright Center website http://www.tufts.edu/as/wright_center/index.html**
5) **Good Luck – and May the Stars Be With You!**

Section A: Use Image Sheet A to answer questions in this section. Place all answers in Section A of the Response Page.

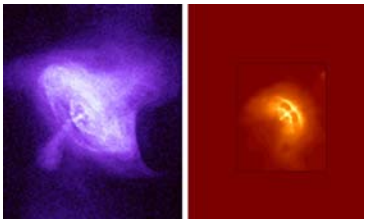


The name of the constellation on the left is _(1)_. This constellation contains the globular cluster shown in which image on Image Sheet A? _(2)_ what is the name of this cluster? _(3)_ In the upper left hand section of this image is an object which is extremely rare in globular clusters. What type of object is it? _(4)_ Why is it rare? _(5)_ Image A is an HR diagram of this cluster. What is the apparent magnitude of the main sequence stars? _(6)_ The brightest stars in this cluster are giants and supergiants with absolute magnitudes ranging from -3 to -4.5. What is the maximum distance to this cluster? _(7)_ What is the minimum distance to this cluster? _(8)_ This cluster contains the double x-ray binary system shown in which image? _(9)_



The image on the left is a close-up of which image on Image Sheet A? _(10)_ What is the name of this image? _(11)_ What type of object is it? _(12)_ The central object in this image would be plotted on which of the green-colored HR diagram(s)? _(13)_ What was the stellar classification for the progenitor star for this object? What was the approximate mass of the progenitor star? _(14)_

What types of objects are in the image to the right? _(15)_ What is the name of the object furthest to the right? _(16)_ This object is located within two of the images on Image Sheet A. Which two images contain this object, and what wavelengths were they imaged in? _(17)_



Look at Image M on Image Sheet A – it contains the spectrum of an object named 3C273 (top) with an optical comparison spectrum below. The three strong lines seen in 3C273 marked Hd, Hg, and Hb are hydrogen lines. At rest on Earth they correspond to the following wavelengths: Hb = 4861 A, Hg = 4340 A, and Hd = 4102 A. These lines and three others are identified in the comparison spectrum below that of 3C273. (A = 10^{-10} m) Use Image M and the ruler to calculate the velocity of 3C273. _(18)_ What is the distance to 3C273? _(19)_ What type of object is 3C273? _(20)_ One of the images contains a similar object, which image is it? _(21)_

Section B: Use Image Sheet B to answer questions in this section. Place all answers in Section B of the Response Page.

The LMC galaxy to the left is located in what constellation? _(1)_ Which two x-ray images on Image Sheet B contain objects located within this galaxy? _(2)_ One of these images contains a star-forming region - what is the name of this region? _(3)_ Which image shows this same region in the optical bandwidth? _(4)_ What is the name and type of object located in the other image? _(5)_

The image to the right contains an object that might be evidence of a new phase state of matter. What is the name of this object? _(6)_ What type of object is it? _(7)_ Which image on Image Sheet B contains this object? _(8)_ Which constellation image contains this object? _(9)_ What is the name of the constellation? _(10)_ This object represents a half-way stage between what two products of stellar evolution? _(11)_

What is the name of the object located within the image to the left? _(12)_ What is this object? _(13)_ Which image on Image Sheet B also contains this object? _(14)_ Image V on Image Sheet B contains what object? _(15)_ What type of object is it? _(16)_ Where is this object located? _(17)_ Image S on Image Sheet B is imaged in what wavelength? _(18)_ Where is it located in relative to the MWG? _(19)_ Which image shows the constellation this object is located it? _(20)_

Image Z contains a massive 130 solar mass star named Melnick 34. Calculate the time amount of time this star will remain on the Main Sequence. _(21)_

Image AA contains a protostar located within Image Z. Use the ruler and Image AA to calculate the following. What is the radius of the circumstellar accretion disk in AU's? _(22)_ In kilometers? _(23)_ The protostar has one solar mass. What is the orbital period (in years) of a particle at the outer edge of the disk? _(24)_ At a speed of 200 km/s how long does it take gas to transverse the entire visible length of the jet? _(25)_

Section C: Use The HR Diagram and both Image Sheets (A and B) to answer questions in this section. Place all answers in Section C of the Response Page. If the answer to any question is that the object is NOT represented by any HR Diagram relation and therefore not located on an HR Diagram then the answer is "NOT APPLICABLE" – so enter the letters NA.

Indicate the location on the HR Diagram of this spectrum. _(1)_

The object in Image Y is a close-up of the object from Image J. Where does this object belong on the HR Diagram? _(2)_ Image J contains several bluish objects. Where do they belong on the diagram? _(3)_ This same image contains some tiny red objects in the upper left corner. Where do these objects belong on the diagram? _(4)_

Where does the object in Image I belong on the HR Diagram? _(5)_ Where does the object at the center of Image I belong on the HR Diagram? _(6)_

Where would you find the following objects on the HR Diagram?
The most luminous and coolest? _(7)_
The most luminous and hottest? _(8)_
The coolest living star? _(9)_
The hottest and dimmest? _(10)_
The hottest and brightest? _(11)_
Companion stars to white dwarfs that go nova? _(12)_
The youngest, most massive stars? _(13)_

Indicate the location on the HR Diagram of this spectrum. _(14)_

Where would the object in Image D be located? _(15)_
Where would the object in Image AA be located? _(16)_
Where would be majority of the stars in Image E be located ? _(17)_

Indicate the location on the HR Diagram of this spectrum. _(18)_

In which location on the HR Diagram would an object first appear that ends up in location D? _(19)_
List the sequence of locations that the object in Image P went through on the HR Diagram in the process of developing in this object. _(20)_

Response Sheet: TEAM #_____ TEAM NAME_____

Section A:

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Section B:

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