

# Astronomy

# ANSWER KEY

# KEEP SECURE

## New York State Science Olympiad Regional Competition 2012

### NOTES

Feel free to edit this for your region as you see fit.

Allow some latitude on calculated responses due to variously reported constants. Generally, any team that comes close to this key, knew what they were doing; wrong answers are usually very wrong. Use your judgment, and be consistent.

I like to give a copy of the event to each individual, and one copy of the answer form to each team. It helps if you put the answer form on different color paper.

I recommend printing the event in color.

Please keep the bibliography handy, but I don't think you need to give every team a copy. Please collect back all papers from the teams.

1. A binary star system has an orbital period of 83.47 years. Express this in the standard SI units of time, seconds. Express your answer in scientific notation.  $2.63 \times 10^9$  sec.  
**(83.47 x 365.25 x 24 x 60 x 60)**

2. A pair of binary stars have a mean separation of 18.92AU. Express this in the standard SI units of distance, meters. Express your answer in scientific notation.  $2.838 \times 10^{12}$ m  
**(18.92 x 1.5 x 10<sup>11</sup>)**

3. What is the total mass of a binary system if the orbital period is 64.37 years, and the mean separation is 17.83AU? Express your answer in kg, and in scientific notation.  $2.748 \times 10^{30}$ kg

$$64.37\text{years} = 2.03 \times 10^9 \text{sec.} \quad 17.83\text{AU} = 2.675 \times 10^{12} \text{m}$$

$$m = (4\pi^2 r^3) / GT^2$$

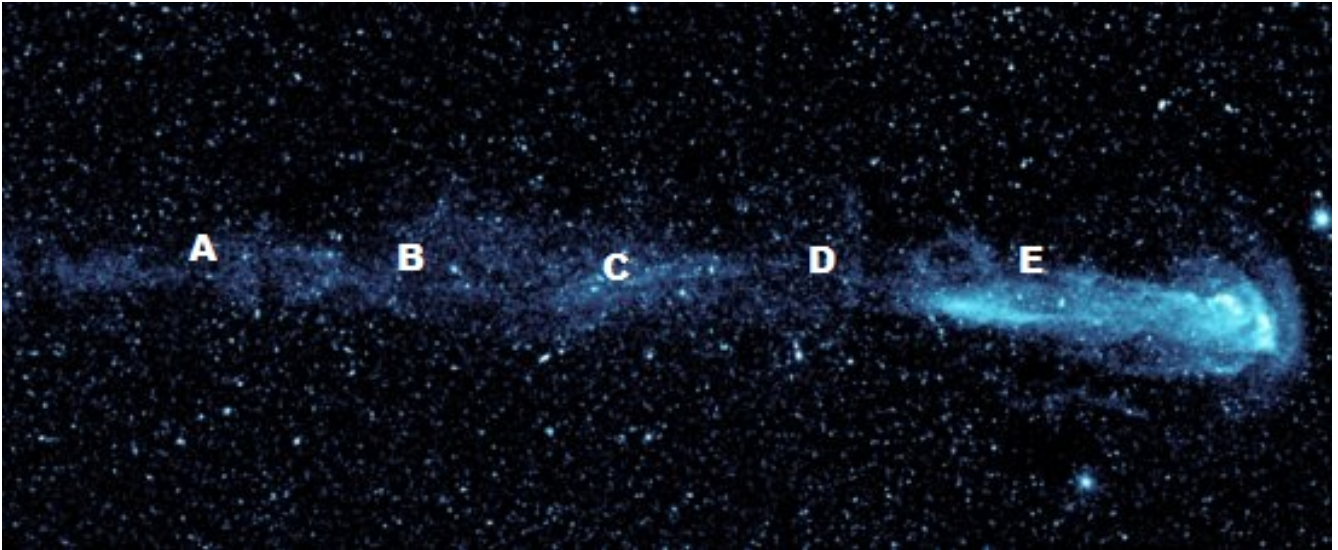
$$m = [4\pi^2 (2.675 \times 10^{12})^3] / [(6.672 \times 10^{-11}) \times (2.03 \times 10^9)^2]$$

4. A binary star system (star A and star B) has a total mass of  $3.804 \times 10^{30}$ kg, and a mean separation of  $6.24 \times 10^{12}$ m. Star A has been determined to be  $2.08 \times 10^{12}$ m from the barycenter. What is the mass of star A? Express your answer in kg, and in scientific notation.  $2.536 \times 10^{30}$ kg

$$m_A = M[(r-r_A)/r]$$

$$m_A = 3.804 \times 10^{30} [(6.24 \times 10^{12} - 2.08 \times 10^{12}) / 6.24 \times 10^{12}]$$

5. Another binary star system (stars A and B) has a total mass of  $8.23 \times 10^{30}$ kg. The mass of star A has been determined to be  $5.19 \times 10^{30}$ kg. What is the mass of star B? Express your answer in kg, and in scientific notation.  $3.04 \times 10^{30}$ kg.  $m_B = M - m_A = 8.23 \times 10^{30} \text{kg} - 5.19 \times 10^{30} \text{kg}$ .



6 & 7. In alphabetical order, what are the two most common names for the Sci Oly featured object shown in the image above? **Mira, Omicron-ceti**

8. Which letter in the picture best approximates the location of material that was ejected from the surface of this star 20,000 years ago? (Local time frame of reference.) **B, according to Dr. Robert Hurt, Hidden Universe Showcase, the entire tail represents about 30,000 years of material being ejected. Proportionally, go back about 2/3 of the way along the tail yields B.**

9. This image graphically displays this star's: **B, this is the lateral component of the actual, or space motion, as seen from earth. Radial is the approach/recede component.**

- |                  |                  |
|------------------|------------------|
| A. Kepler motion | C. radial motion |
| B. proper motion | D. space motion  |

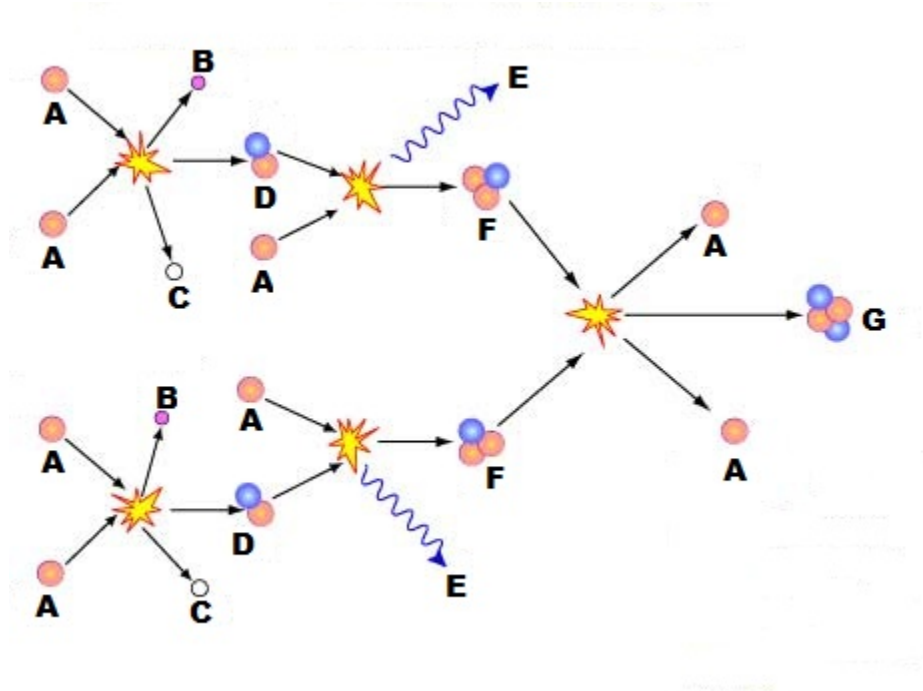
10. This image shows **B**

- A. carbon in this visible.
- B. hydrogen in the ultraviolet.
- C. helium in the ultraviolet.
- D. hydrogen in the x-ray.
- E. helium in the x-ray.

11. Draw a dot with a circle around it on the chart in your answer packet representing the location of this object. **RA = 2h 19m 20.79s, Dec. = -2° 58' 39.513"**



12. When pair of binary stars form simultaneously from the same gas and dust, one will virtually always leave the main sequence before the other. Why? **It is more massive.**
13. Prior to a type 1a supernova explosion, material transfers from one member of a binary pair to the other, as illustrated above. What type of star is shown on the left side of this illustration? **White Dwarf**
14. What type of star is shown on the right side of this illustration? **Red Giant**
15. What is the name of the structure of the material spiraling around and into the left hand star? **Accretion Disc**
16. Expressed in solar masses, a type 1a supernova will occur when the left hand star reaches what mass? **1.4 solar masses**
17. Expressed in kg, and in scientific notation, a type 1a supernova will occur when the left hand star reaches what mass?  **$2.864 \times 10^{30}$  kg**
18. This point at which a type 1a supernova occurs is named after an Indian astronomer who first predicted it in 1930. Correctly spelled, what is it called. **Chandrasekhar Limit**



19. The diagram above represents **D**

- A. carbon synthesis in white dwarf stars.
- B. carbon synthesis in the core of red giant stars.
- C. helium fission in the core of main sequence stars.
- D. helium fusion in the core of main sequence stars.
- E. lithium degeneration in type 1a super novae.

For questions 20 – 26 identify what each of the letters in the diagram above represents, selecting your answers from the list below:

$^{12}\text{C}$ ,  $^{14}\text{C}$ ,  $^1\text{H}$ ,  $^2\text{H}$ ,  $^3\text{H}$ ,  $^4\text{H}$ ,  $^1\text{He}$ ,  $^2\text{He}$ ,  $^3\text{He}$ ,  $^4\text{He}$ ,  $^6\text{Li}$ ,  $^7\text{Li}$ , dalek, dilithium, gamma ray, microwave, neutrino, positron, quidditch

20. A  $^1\text{H}$

21 & 22. B and C (in either order) **neutrino & positron**

23. D  $^2\text{H}$

24. E **gamma ray**

25. F  $^3\text{He}$

26. G  $^4\text{He}$

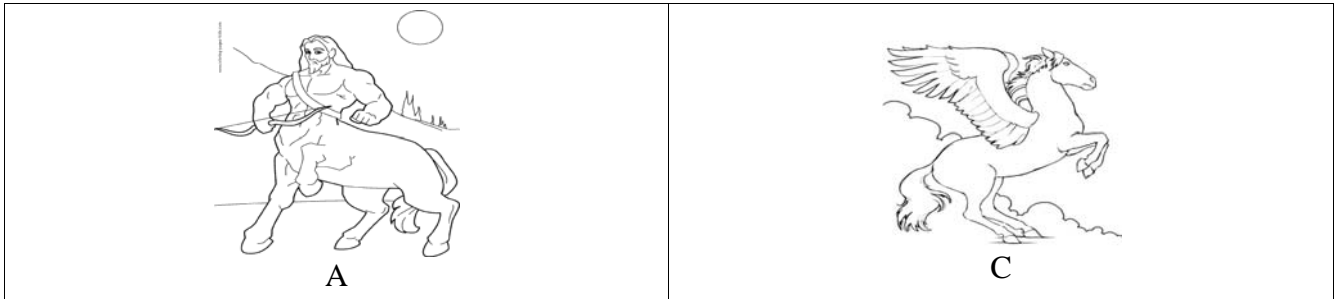


27. Which Sci Oly featured object is shown above? **Rosette Nebula**

28. It is **B**

- A. a supernova remnant.
- B. an HII region.
- C. an irregular galaxy.
- D. an accretion disk.

29. This object is found in a constellation named after which of the following: **D**





B



D

30. The following objects are listed in alphabetical order. List them in chronological order to represent the evolutionary stages of a star about the same mass as our sun.

- |                  |                         |
|------------------|-------------------------|
| black dwarf      | <b>GMC</b>              |
| GMC              | <b>protostar</b>        |
| main sequence    | <b>main sequence</b>    |
| planetary nebula | <b>red giant</b>        |
| protostar        | <b>planetary nebula</b> |
| red giant        | <b>white dwarf</b>      |
| white dwarf      | <b>black dwarf</b>      |

31 – 34. Fill in the blank spaces in the color index table below. Copy your answers for the numbered cells onto your answer sheet.

Star	B	V	Color Index
Alpha Crucis	31. <u>0.56</u>	0.81	-0.25
Beta Crucis	1.15	1.3	32. <u>-0.15</u>
Gamma Crucis	3.22	1.63	33. <u>+1.59</u>
Delta Crucis	2.59	34. <u>2.78</u>	-0.19

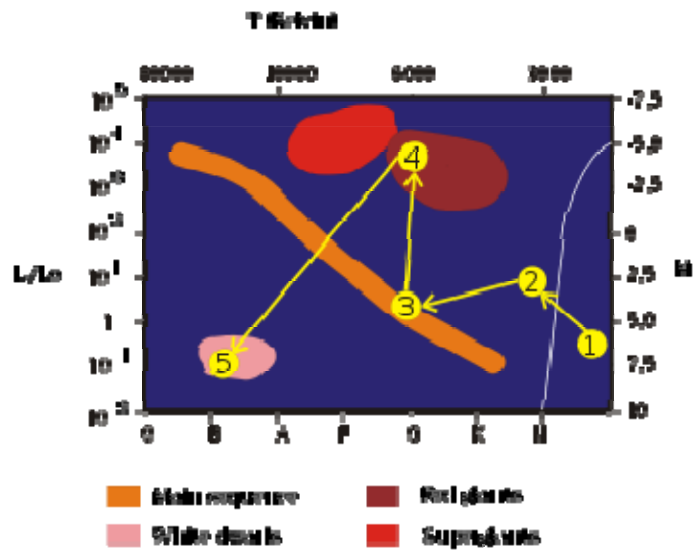
35. What is the name of the star in the chart above that is a red giant? **Gamma Crucis**

36. What is the name of the star in the chart above that has the highest surface temperature? **Alpha Crucis**

37. Based on the information that is in the chart above, what is the magnitude of Gamma Crucis? **1.63**

38. A certain star has a surface temperature of 6,000K. What is its peak wavelength expressed in angstroms. **4830Å**, Wien's Law  $\lambda_{\max} = b/T$ , Wien's Displacement Constant  $b=2,897,768.5\text{nm}$ , **T=temperature in Kelvin, 483.0nm = 4830Å**

39. What is the distance to a star, in pc, if its apparent magnitude is 0.14 and its absolute magnitude is -7.1? **281pc**,  $d=10^{(m-M+5/5)}$ ,  $d=10^{(0.14- -7.1+5/5)}$



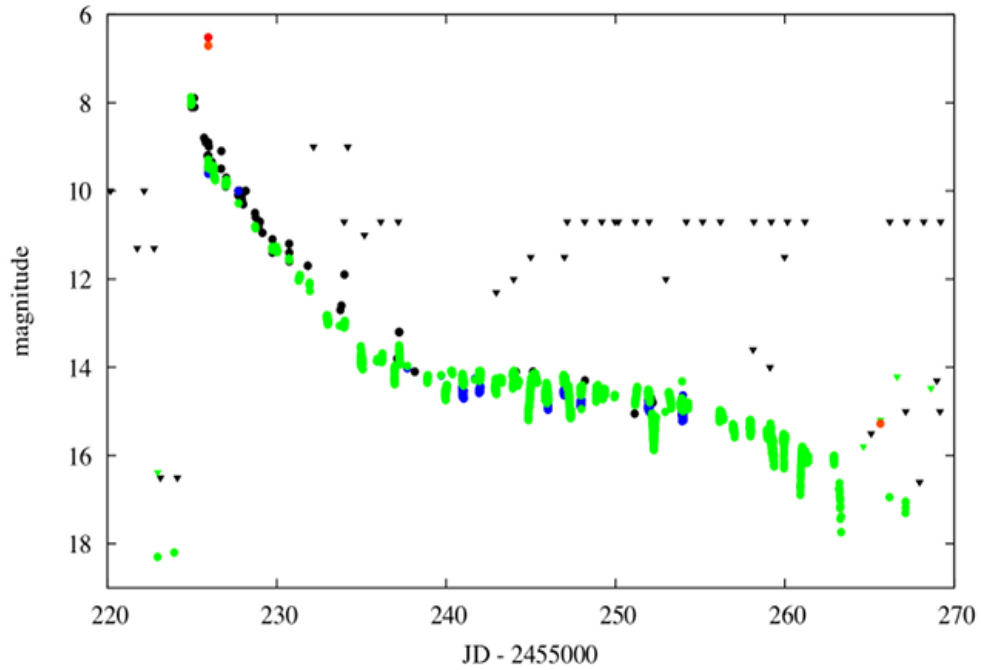
For each of the following Sci Oly featured objects, write the numbered region of the H-R diagram above that best matches it.

40. BP Psc 4

41. Sirius B 5

42. T Tauri 2





43. Which Sci Oly featured object is represented by the AAVSO light curve shown above? **U Scorpii**
44. On what date were these observations of its most recent outburst made? **January 28, 2010**
45. If you were to make an observation of this object a 6:30pm EST, on February 4, 2012, which Julian Date should you record with your observation? **C**
- A. JD 2455863.697222
  - B. JD 2455961.979167
  - C. JD 2455962.479167
  - D. JD 2456147.927083

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