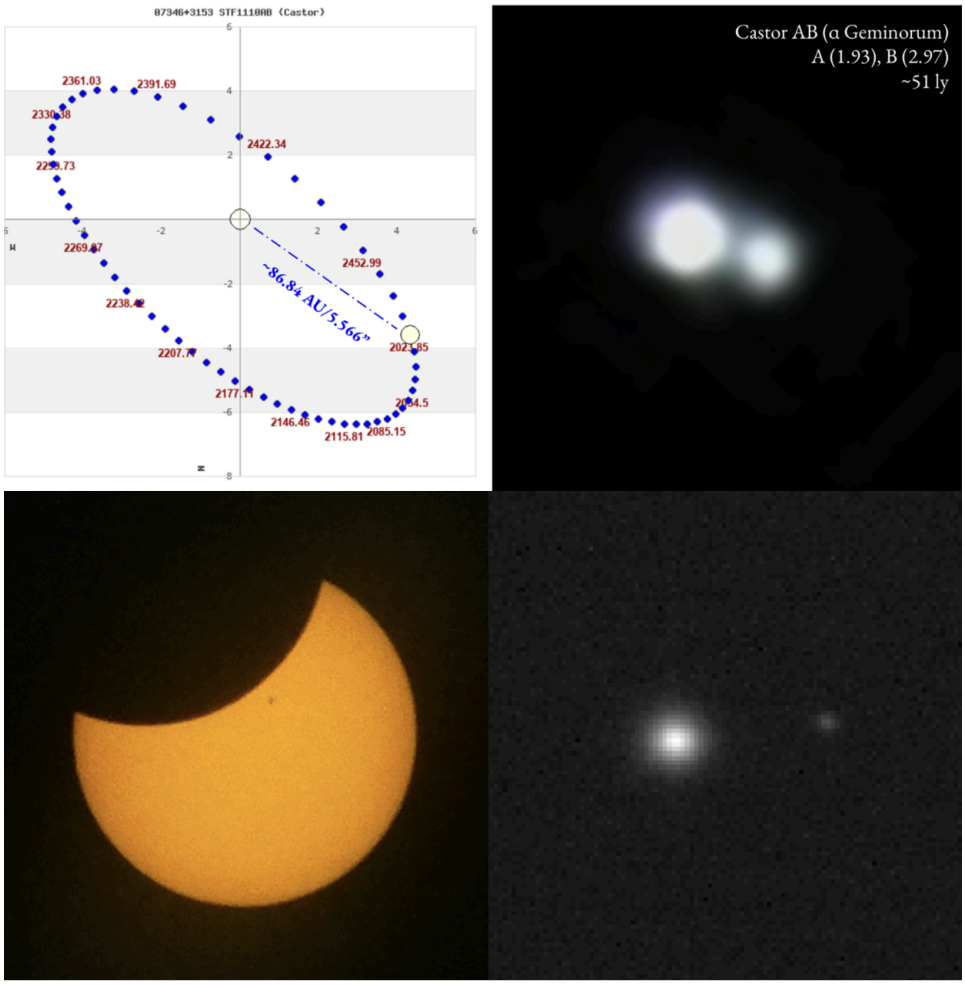
Science Olympiad

# COBRA Invitational 2024-2025

# Reach for the Stars - TEST

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## Directions:

- Do not open the test until told to start!
- Each team will be given 50 minutes to complete the test.
- Test is divided into 4 parts: General Knowledge, Telescopes, DSOs, and Math

**Team Name: _____**

**Team Number: _____**

**Score: ___ /100**

## General Knowledge [25 pts]

All questions in this section are 1 point each

1. Consider a Star A and Star B with apparent magnitude 1 and apparent magnitude 0 respectively. Which star is brighter to the observer?
    a. Star A because it has an apparent magnitude of 1
    b. Star B because it has an apparent magnitude of 0
    c. Unable to determine since it would depend on distance
    d. Equally bright, since apparent magnitude does not depend on distance
2. The Schwarzschild radius is directly derived from what equation?
    a. Escape Velocity Equation
    b. Kepler's 3rd Law
    c. Stefan-Boltzmann Law
    d. Jean's Mass
3. The Period-Luminosity relationship for Cepheid variable stars
    a. Linear
    b. Logarithmic
    c. Quadratic
    d. Cubic
4. Where are white dwarfs found on the Hertzsprung-Russell Diagram?
    a. Center
    b. Top right
    c. Lower Right
    d. Lower Left
5. What is the one way a Neutron Star can be formed?
    a. Type II Supernovae
    b. Type Ia Supernovae
    c. 2 White Dwarfs Colliding
    d. Recurrent Novae
6. The James Webb Space Telescope has discovered many binary brown dwarfs in what celestial object in the sky?
    a. Small Magellanic Cloud
    b. Orion Nebula
    c. Albireo
    d. Messier 44
7. What causes Planetary Nebulae to form?
    a. Gravitational Contraction
    b. Ignition of Hydrogen Fusion
    c. Strong Stellar Winds
    d. Kelvin-Helmholtz Mechanism
8. What happens directly before the horizontal branch of an HR diagram?
    a. Helium Flash
    b. Ignition of Hydrogen Fusion
    c. Type Ia Supernova
    d. Roche-Lobe Overflow

9. In Mass-Transfer Binary Systems, as mass is transferred from the primary star to the secondary star with no conversions to other forms of energy, the orbital period…
    a. Increases
    b. Decreases
    c. Remains constant
    d. Is converted into thermal energy
10. The orbital energy of a satellite in an elliptical orbit is highest at
    a. Perihelion
    b. Aphelion
    c. Increases at acceleration, decreases at deceleration
    d. Remains constant
11. What occurs on the Asymptotic Giant Branch?
    a. Hydrogen begins to burn in the core
    b. Helium begins to burn in the core
    c. Hydrogen begins to burn in a shell
    d. Helium begins to burn in a shell
12. The radius of a White Dwarf gets bigger as mass increases
    a. True
    b. False
13. What letter on the Yerkes Classification is the Sun on?
    a. V
    b. Ia
    c. II
    d. III
14. The Vis-Viva equation is derived directly from
    a. Kepler's 2nd law
    b. Conservation of Energy
    c. Escape Velocity Formula
    d. Eclipsing Binary Star Ratios
15. The free-fall timescale for molecular cloud collapsing into a protostar is proportional to
    a. $\frac{4\pi^2}{GM}$
    b. $M^2$
    c. $\sqrt{\frac{1}{\rho}}$
    d. $R^{1/2}$
16. After the Asymptotic Giant Branch in the Sun, what element does the star begin to fuse in the core?
    a. Helium
    b. Hydrogen
    c. Oxygen
    d. None

17. What element is not produced in the cores of stars (hint: think about atomic numbers and nuclear fusion)?
    a. Helium
    b. Iron
    c. Lithium
    d. Magnesium
18. It's estimated what percentage of stars have one or more stellar companion?
    a. 80%
    b. 50%
    c. 30%
    d. 10%
19. The boundary at which stellar wind and particles from the interstellar medium are in equilibrium is called
    a. Bow Shock
    b. Roche Lobe
    c. Heliosphere
    d. Hydrostatic Equilibrium
20. A white dwarf is accreting a layer of hydrogen from another star, what would the other star likely be?
    a. G Main-Sequence Star
    b. K Main-Sequence Star
    c. Red Giant Star
    d. O Subgiant Star
21. RR Lyrae stars are variable stars at what stage of stellar evolution?
    a. Asymptotic Giant Branch
    b. Horizontal Branch
    c. Subgiant Branch
    d. Helium Flash Point
22. What main sequence type star has the highest average density?
    a. O
    b. B
    c. G
    d. M
23. For stars that do not produce a White Dwarf as a stellar remnant, what element can they fuse past?
    a. Helium
    b. Boron
    c. Oxygen
    d. Neon
24. What causes Neutron Stars to rapidly rotate?
    a. Mass Transfer in a Binary System
    b. Stellar Winds "blowing"
    c. Collapse of Protons and Electrons into Neutrons
    d. Ignition of a layer of gas into nuclear fusion

25. What principle causes Pulsars to form?
    a. Newton's Third Law
    b. Conversation of Angular Momentum
    c. Wien's Law
    d. Planck's Law

**Telescopes [20 pts]**

26. Which telescope is shown in image H? [1 pt]

    _____

27. In which range of the electromagnetic spectrum does this telescope observe? [1 pts]

    _____

28. Which method of exoplanet detection does this telescope utilize? How does this technique work? [2 pts]

    _____

29. What is one advantage and one drawback of the above method? [2 pts]

    _____

    _____

30. This telescope can also measure the CMB. What does this acronym stand for, and what does it mean? [2 pts]

    _____

31. Which telescope is shown in image I? [1 pt]

    _____

32. How big is the main mirror of this telescope? [1 pt]

    _____

33. In which year did the majority of its parts stop working? Which year did this telescope formally cease operations? [2 pts]

    _____

34. Which wavelengths does this telescope observe? How many channels does the main camera have? [2 pts]

    _____

35. Which telescope is shown in image J? [1 pt]

_____

36. In which range of the electromagnetic spectrum does this telescope observe? [1 pts]

_____

37. This telescope is known to measure technosignatures. What are technosignatures? Provide 2 examples. [4 pts]

_____

**Deep Sky Objects [30 pts]**

38. Identify the constellation in Image A, and give its English meaning. [2 pts]

_____

39. What star is labelled 2 in image A? [1 pt]

_____

40. Which image shows this star? [1 pts]

_____

41. This star is part of a binary system. What types of stars are in this system? [2 pts]

_____

42. Which stellar characteristic was measured for the first time with this star? Which concept did this discovery begin? [2 pts]

_____

43. Identify the constellation in Image B, and give its English meaning. [2 pts]

_____

44. The Large Magellanic Cloud is covered within this constellation and which other? [1 pt]

_____

45. What type of DSO is SN 1987A? Which image shows SN 1987A? [2 pts]

_____

46. Which elementary particle from the explosion, along with light, reached Earth in 1987? Why do most supernova explosions emit this elementary particle? [2 pts]

_____

47. Identify the constellation in Image C, and give its English meaning. [2 pts]

_____

48. What type of object is SN 1604? What does its name imply? Who discovered and studied this supernova? [3 pts]

_____

49. Which galaxy is this supernova located in? How many any other supernova explosions have occurred in this galaxy since the year this supernova was discovered [2 pts]

_____

50. Identify the constellation in Image D, and give its English meaning. [2 pts]

_____

51. Name 2 other water-related constellations located near this constellation. [2 pts]

_____

52. What star is labelled 6 in image D? [1 pt]

_____

53. Why is this star significant for variable stars? [1 pt]

_____

54. Which image shows this star? Which space telescope took this image? [2 pts]

_____

**Math [25 pts]**

Label the following symbols with the variables/constants they commonly represent in astronomy. If the symbol represents a constant, write the constant WITH UNITS. [2 pts per constant, 1 pt per variable] [9 pts total]

55. σ (constant): _____

56. G (constant): _____

57. c (constant): _____

58. F (variable): _____

59. λ (variable): _____

60. R (variable): _____

Answer the following questions relating to equations used in astronomy:

61. What is the vis-viva equation used to calculate? What is another name for it? [2 pts]

    _____

62. Which law dictates the expansion of the universe? [1 pts]

    _____

63. Write Hubble's law. What does each symbol stand for? [4 pts]

    _____

    _____

64. Is the value for Hubble's constant fixed? If not, why so? [2 pts]

    _____

65. Which law is used to calculate luminosity of a star, given radius and temperature? [1 pts]

    _____

66. If a star's temperature is doubled and its radius is shrunk to ⅓ of its original size, what is the ratio of the new luminosity of the star to the original? Show your work [2 pts]

    _____

67. How is a star's flux calculated? [1 pt]

    _____

68. Write Kepler's Laws of Planetary Motion [3 pts]:

    a. _____

    b. _____

    c. _____