SCIOLY SUMMER STUDY SESSION 2014 – ASTRONOMY

This test assumes the 2014-2015 topic is Variable Stars and Stellar Evolution.

DSO LIST

AH Leo
Beta Lyrae
BY Draconis
Cepheus B
Delta Scuti
Epsilon Aurigae
GK Persei
Omega Centauri
R Coronae Borealis
RX Andromedae
SN 1006
SN 2006gy
Tarantula Nebula
UV Ceti
Z Andromedae
ZZ Ceti

SCORING

1. Each correct answer is worth 1 point, unless otherwise specified.
2. Questions with multiple answers (such as "What are the S.O. events this year?") will be scored with 1 point for each correct answer, but the number of answers will not be indicated on the test.
3. Individual section scores should be used as tiebreakers in this order – math, topics, DSOs.
4. This test is worth a total of 75 points.

MATH

1. Use the constants provided below.
2. All answers should have proper sig figs.
3. Full credit will be awarded for answers within 10% of the key.
4. All math questions are worth double points when scored (2 points for each correct answer).

CONSTANTS

b = $.0029\ m * K$
c = $3.00 * 10^8\ m/s$
G = $6.67 * 10^{-11}\ N * \left(\frac{m}{kg}\right)^2$
$H_o = 70.\frac{km/s}{Mpc}$
h = $6.63 * 10^{-34}\ J * s$
k = $1.38 * 10^{-23}\ J/K$
σ = $5.67 * 10^{-8}\ \frac{W}{m^2K^4}$

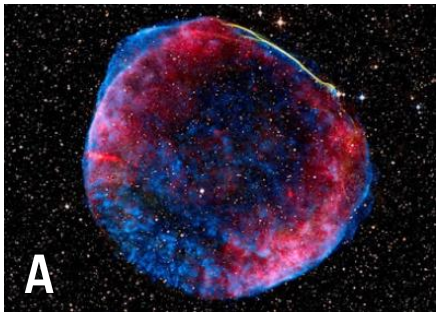
$L_\odot = 3.84 * 10^{26}\ W$
$M_\odot = 1.99 * 10^{30}\ kg$
$R_\odot = 6.96 * 10^8\ m$
$T_\odot = 5800\ K$

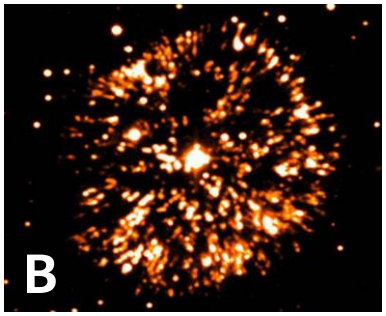
$1\ pc = 3.26\ ly = 206{,}265\ AU = 3.08 * 10^{16}\ m$
$1\ ly = 0.307\ pc = 63240.\ AU = 9.46 * 10^{15}\ m$
Absolute mag. of Type Ia SNe = – 19.6

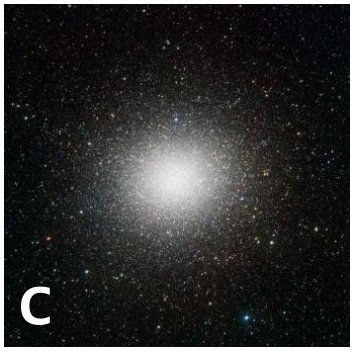
BONUS (+1)

Current Events – Star HV2112 in the SMC is the latest candidate for what type of extremely odd (and so far theoretical) astronomical object?

IMAGE SHEET

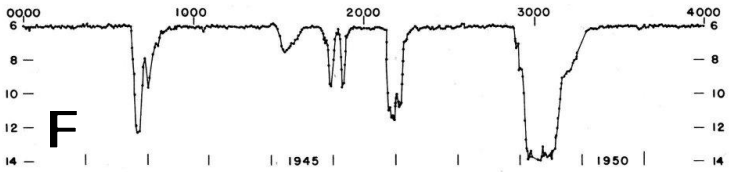

A


B

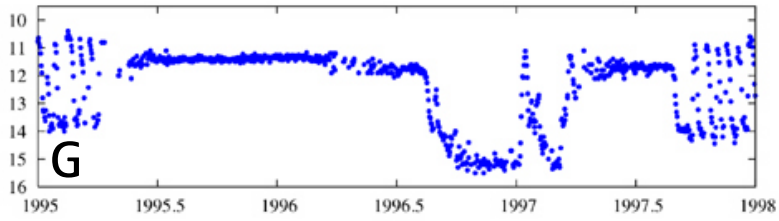

C

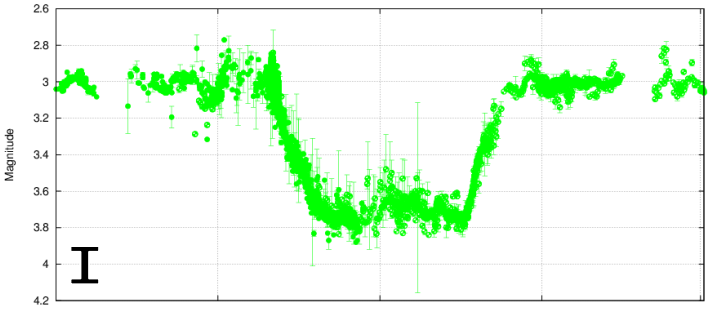

D

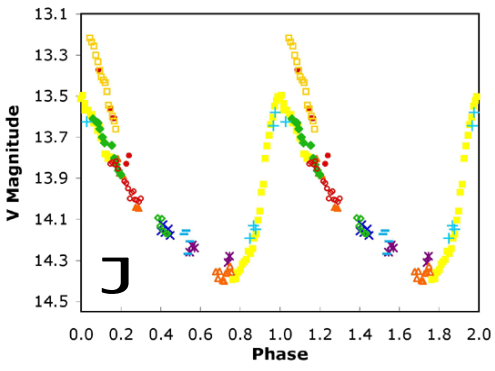

E
LICK
CHANDRA


0000
1000
2000
3000
4000
6
8
10
12
14
1945
1950
F


H


10
11
12
13
14
15
16
1995
1995.5
1996
1996.5
1997
1997.5
1998
G


Magnitude
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
I


V Magnitude
13.1
13.3
13.5
13.7
13.9
14.1
14.3
14.5
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Phase
J

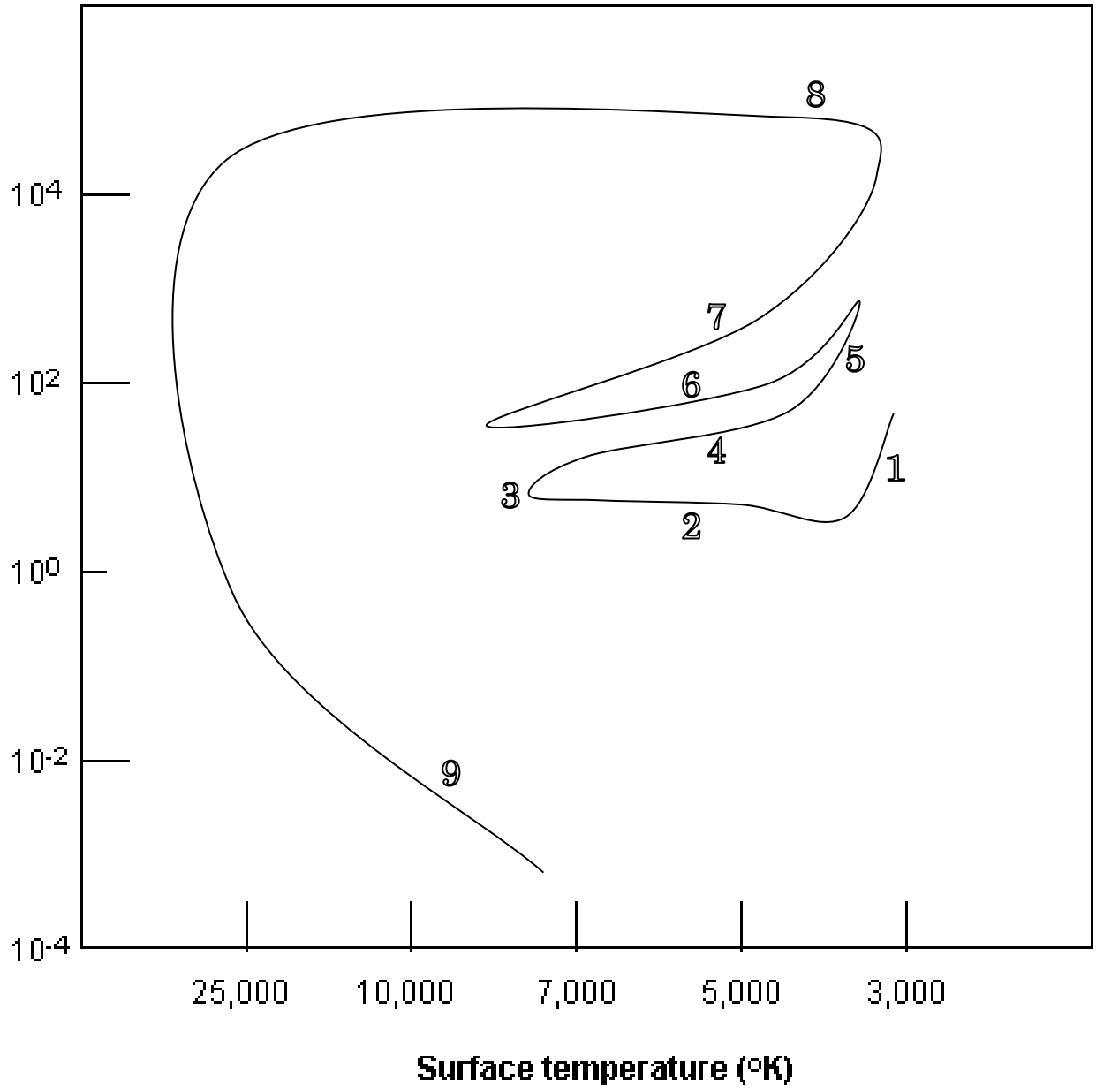
SECTION I – DSOS

1. Which DSO(s) is/are instability strip pulsators?
2. Referring to the DSO(s) in # above, what isotopes (of the same element) are predominantly responsible for pulsation?
3. What is thought to have triggered the star formation in Image H (be specific)?
4. The DSO in Image F is the prototype of a class of variable stars. What spectroscopic feature(s) distinguish this type of variable?
5. What is the name of the process behind the cataclysmic variability of the DSO shown in Image E, and how does this process work? [2 points]
6. According to the GCVS4 (Fourth General Catalog of Variable Stars), which DSO(s) is/are primarily rotating variables?
7. What is one theory for why the DSO in Image I has such a strange light curve?
8. Which DSO(s) is/are examples of the Algol Paradox?
9. BY Draconis is the prototype of a class of variable stars. Which other DSO is thought to also be a part of this variability class?
10. What is the Shapley-Sawyer class of the DSO shown in Image C?
11. Referring to the DSO in # above, why is it theorized to have an origin different from most globular clusters, and what is this different origin? [2 points]
12. What causes non-radial pulsations in ZZ Ceti?
13. Which DSO is the prototype of the "dwarf Cepheids"?
14. What kind of progenitor is thought to have caused the DSO found in Image A?
15. According to the GCVS4 (Fourth General Catalog of Variable Stars), which DSO(s) is/are primarily eruptive variables?
16. The DSO in Image J has long-term variations in luminosity along with its normal variability. What is the term for these long-term variations and what is their period in this DSO? [2 points]
17. What spectroscopic feature(s) distinguish Z Andromedae and other variables of its class?
18. What is thought to have triggered the star formation in Image D (be specific)?
19. The DSO in Image B has most recently been reclassified as what type of variable star?
20. Referring to the DSO in # above, what is one reason why the discovery of an expanding shell surrounding it was very unusual?
21. What is the classification of the DSO in image G in the GCVS4 (Fourth General Catalog of Variable Stars)?
22. Referring to the DSO in # above, what other variable type is it thought to be, and why? [2 points]

SECTION II – TOPICS

23. What astronomical theorem states that a star's structure, and thus its evolution, depends primarily on its mass (and chemical composition)?
24. What is the primary source of energy released by a collapsing protostar?
25. Why do stars with higher masses produce more of their energy from the CNO cycle than the proton-proton chain?
26. Why do stars expand to many times their original size when they become red giants?
27. What name is given to the "zigzag" patterns made by high-mass stars on the HR Diagram during their post-main sequence evolution?
28. Why do Type Ib and Ic supernovae lack hydrogen lines?
29. What is the lower mass limit for a star to explode as a Type II supernova, and why does this limit exist? [2 points]
30. What is the difference between a collapsar hypernova and a regular core-collapse supernova?
31. What processes are responsible for the production of all elements heavier than iron?
32. How can the evolution of stars within a globular cluster be used to calculate the cluster's age?
33. What tool do astronomers use to help determine whether the predicted/modeled period of a variable star is correct?
34. In mass-transfer systems, such as dwarf novae, what theoretical boundary must be filled to allow the transfer of matter?
35. Beta Cephei variables pulsate due to the same mechanism as Cepheid variables, but rely upon a different element to drive pulsation. What is the mechanism, and what is the element? [2 points]
36. Mira variable stars are pulsating late-type giants. What chemical compound is responsible for the variability of these stars?
37. The central stars of planetary nebulae can be variable too! What is the name for this kind of variable star?
38. What is <u>one</u> criterion that the classification of eclipsing binaries has been based on?
39. What are the main categories of intrinsic and extrinsic variable stars? [2 ½ points total – ½ for each category]

40. Label the evolution of a 2 solar mass star on the HR Diagram below, from collapsing dust cloud to stellar remnant. [4 ½ points total – ½ for each correct stage]



1 –

2 –

3 –

4 –

5 –

6 –

7 –

8 –

9 –

SECTION III – MATH

41. Star X and Star Y form a binary system with the plane of orbit nearly edge-on as we observe the system from Earth.

a. The Hα spectral line is normally found at 656.28 nm. In the spectrum of Star X, Hα has a maximum wavelength of 656.40 nm, and in the spectrum of Star Y, it has a maximum wavelength of 656.58 nm. What are the orbital velocities of Star X and Star Y, in km/s? (Assume the recessional velocity of the binary system as a whole is negligible.)

b. The cyclic shifts in the wavelength of Hα have a period of 68.1 days. If the average separation of the binary components has been determined by other means to be $7.45 * 10^{10}$ m, what is the combined mass of Star X and Star Y, in kg?

c. What are the individual masses of Star X and Star Y, in solar masses?

42. The following information is known about Star Z.

Parallax angle	196.7 mas
Apparent magnitude (V)	+4.03
Temperature	5300 K

a. What is its absolute visual magnitude?

b. What is its wavelength of maximum radiation, in nm?

c. What is its radius, in m?

d. By what factor would Star Z's luminosity change if it evolved into a red giant with a radius of 50. times its current radius and a temperature of 3500 K?

e. What is the maximum intensity (irradiance) of the visible light from Star Z on Earth, in W/m^2?