

KEY: Alternative, acceptable answers are given in brackets



Bonus: Name NASA's 6 space shuttles – 1 bonus point per 3 correct answers. (2 pts total)

Atlantis

Challenger

Columbia

Discovery

Endeavour

Enterprise

TEAM NAME/NUMBER: _____, # _____

COMPETITORS' NAMES:

- * Time is NOT a tiebreaker. Tiebreakers will be the individual section scores, in this order: **Ic, Ia, Ib, Id, IIa**. Some questions are designated as further tiebreakers.
- * You have 50 minutes to complete this test to the best of your ability. Good luck. Go!

Reach for the Stars

SECTION Ia: Identify the DSOs on the image sheet (letters on the image sheet correspond to the letters below) and answer the accompanying questions (1 pt each, 35 pts total).

A. *Cas A*

- i. This DSO is the strongest source (outside of our solar system) of what kind of electromagnetic radiation? *Radio (waves)*

B. *Veil Nebula*

- i. What is an alternate name for this DSO? (Hint: has to do with a constellation.)
Cygnus Loop

C. *Andromeda Galaxy*

- i. What is this DSO's Messier catalog number? *M31 [31]*
- ii. Which other DSO is likely to collide with this DSO in about 2.5 million years?
Milky Way Galaxy

D. *Pleiades*

- i. Approximately how old are the stars in this DSO? *Accept 75-150 million years*
- ii. What constellation is this DSO found in? *Taurus*

E. *Crab Nebula*

- i. What object causes this DSO's x-ray emissions? *Crab Pulsar [neutron star, pulsar]*
- ii. When was the supernova that created this nebula seen from Earth? *1054*

F. *Tycho's SNR*

- i. Why is this DSO named after a specific person? *Tycho is generally credited as the most accurate observer. [He compiled many observations of the SNR into a book.]*
- ii. What caused the cataclysmic event that created this DSO? *Type Ia supernova. [White dwarf accumulated too much mass and exploded, SN 1572]*

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G. *Globular Cluster*

- i. What is this DSO's Messier catalog number? *M13 [13]*

H. *Butterfly Cluster*

- i. What constellation is this DSO located in? *Scorpius*
- ii. What is the name of the bright orange star? **(T4)** *BM Scorpii*

I. *Trapezium*

- i. What larger nebula is this DSO part of? *Orion Nebula [M42]*

J. *Helix Nebula*

- i. What kind of nebula is this DSO? *Planetary Nebula*
- ii. What constellation is this DSO found in? *Aquarius*

K. *Milky Way Galaxy*

- i. What is the supermassive black hole at the center of this galaxy designated as?
*Sgr A**

L. *Large Magellanic Cloud [LMC]*

- i. What is this DSO's "little companion" called? *Small Magellanic Cloud [SMC]*
- ii. Why are this DSO and its "little companion" of interest? *Some of the closest galaxies to our own. [Contain interesting objects such as nebulae, clusters, etc.]*
- iii. What shape galaxy is this DSO? *Irregular [Irr, SB(s)m]*

M/N. These pictures are of the same DSO in different wavelengths. What DSO is it?

M84

- i. When was the most recent confirmed supernova in this galaxy? *1991*
- ii. What shape galaxy is it? (Spiral, elliptical, etc.) *Lenticular [S0, E1]*

Section Ib: Answer the following questions about the constellations. (22 pts total)



1. Which two constellations are fully visible in the image at left? (2 pts) *Orion and Auriga*

2. What star is indicated by the arrow? (1 pt)
Aldebaran [α Tau, α Tauri, Alpha Tauri, etc.]



3. What constellation is outlined in the image at right? (Hint: the other constellation may help.) (1 pt) *Sagittarius*

4. Which of the constellations on the list lie along the ecliptic? (8 pts) *Aquarius, Cancer, Gemini, Leo, Sagittarius, Scorpius, Taurus, Virgo [do not accept simply "Zodiac constellations" or similar]*

5. What constellation is visible in the lower left of the image at right? (1 pt) *Canis Major*

6. What is the bright star visible left of center? (1 pt) *Sirius (A)*



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7. Which constellation is visible in the image at left? (1 pt) *Cygnus [may also accept Lyra]*
8. What is the Bayer designation of the star indicated by an arrow? (2 pts) **(T2)** *α Lyr, Alpha Lyrae, etc.*
9. What constellation is M51 located in? (1 pt) *Canes Venatica [Canes Venatici]*
10. Polaris will not always be the North Star. Why is this? (2 pts) **(T1)** *Answers should mention axial precession or precession of the equinoxes. [The Earth's axis wobbles in a circle (precession) and as*

the pole moves along this path, it "points" at different stars in the night sky.]

11. Name two other (northern) pole stars. (2 pts) *γ (gamma) Cephei [Alrai], ι (iota) Cephei, Deneb, Vega, α Draconis [Thuban], β Ursae Minoris [Kochab]*

Section Ic: Answer the following questions about stars and stellar evolution. (39 pts total)

1. Which star on the list is a flare star? (1 pt) *Wolf 359*
2. How often does said flare star flare? (1pt) *Minutes to days, but irregular*
3. What luminosity class are main sequence stars on the H-R diagram? (1 pt) *V*
4. What is the general relationship between the mass of a star and its lifespan? (2 pts) *The mass of a star is inversely related to its expected lifespan. [The more massive the star is, the shorter its lifespan. The less massive the star is, the longer its lifespan.]*
5. Why is this the case (referring to question #4)? (2 pts) *Massive stars undergo more intense fusion at their cores and burn through their fuel much faster than small stars.*
6. Which star is the brightest in the nighttime sky? (1 pt) *Sirius*

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7. What class star is Algol A? (1 pt) O **B** A F G K M
8. What is (usually) the brightest star in Orion? (1 pt) *Rigel*
9. What is Alpha Orionis better known as? (1 pt) *Betelgeuse*
10. What famous asterism is formed by the three stars Altair, Deneb, and Vega? (1 pt)
Summer Triangle
11. What is the Sun's spectral class? (1 pt) *G2V [G]*
12. What is the Sun's absolute magnitude? (1 pt) *Accept 4.8 to 4.9*
13. At what distance are apparent and absolute magnitude the same? (1 pt) *10 parsecs [32.6 light years]*
14. What do the H and R stand for in "H-R diagram"? (2 pts) *Hertzsprung, Russell*
15. Antares emits a large portion of its energy in what non-visible wavelength? (1 pt)
Infrared
16. Which star on the list is a white dwarf? (1 pt) *Sirius B [do not accept "Sirius"]*
17. White dwarfs can go supernova when they approach a certain mass. What is the name of this "critical mass"? (2 pts) *Chandrasekhar Limit*
18. What type of supernova results from a white dwarf gaining too much mass and exploding? (1 pt) *Type Ia*
19. Vega, Altair, and Regulus are flattened at the poles and bulging at the equator. What causes this? (2 pts) *Rapid rotation [high spin speed, non-solid composition]*
20. Which star, excluding the sun, is the closest to Earth? How far is it (to .1 light years)? (2 pts) *Proxima Centauri, 4.2 light years*
21. What is the term for stars that don't have enough mass to start nuclear fusion? (1 pt)
Brown dwarfs

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22. What is the main difference between Population I and Population II stars? (2 pts) *Pop I*

stars (younger) have higher metallicities than Pop II (older) stars. [Pop I stars are metal-rich (metal = anything other than H and He), Pop II stars are metal-poor.]

23. Why are these two kinds of stars different (referring to question #22)? (2 pts) **(T3)** *The*

older Pop II stars formed when there was little in the Universe but H and He. After these stars had fused H and He into heavier elements, they often scattered material back into space (through supernovae and planetary nebula). The younger Pop I stars then formed out of gaseous clouds of H, He, and the metal-rich remains of Pop II stars.

24. What are the evolutionary stages of a Sun-sized star? (4 pts)

- a. *Protostar [condensing gas]*
- b. *Main sequence star*
- c. Red giant
- d. *Planetary nebula [white dwarf]*
- e. *White dwarf [black dwarf, only accept if answer for d was white dwarf]*

25. What about a much more massive star? (5 pts)

- a. *Protostar [condensing gas]*
- b. *Main sequence star*
- c. Red giant
- d. *Type II supernova*
- e. *Neutron star or black hole*

Only a couple more pages to go! --->

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Section Id: Answer the following questions about open and globular clusters. (10 pts total)

1. Stars in clusters are bound together by what? (1 pt) *Gravity*
2. Which type of cluster is often found in the halo of galaxies? (1 pt) *Globular clusters*
3. Where is the other type of cluster usually found? (1 pt) *Galactic disk [spiral arms]*
4. What is the closest open cluster to Earth? (1 pt) *Hyades*
5. Which kind(s) of cluster contain(s) blue stragglers? (1 pt) *Both*
6. Why are blue stragglers more likely to form within clusters? (2 pts) **(T5)** *Blue stragglers are thought to form when two smaller stars collide. Higher star density in clusters equals greater chance of collision, thus, blue stragglers are more likely to form.*
7. What kind(s) of cluster is/are considered “young”? (1 pt) *Open clusters*
8. What kind(s) of cluster is/are considered “old”? (1 pt) *Globular clusters*
9. The age of globular clusters puts a bound on what important part of cosmology? (1 pt) *The age of the Universe*

Section Iia: Classify the following galaxies based on the Hubble Sequence. Classification can be somewhat subjective, so a range of answers may be accepted. (16 pts total)



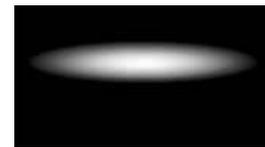
Irr



SBb/SBc



So



E7



Sa/Sb



Sb/Sc



SBa



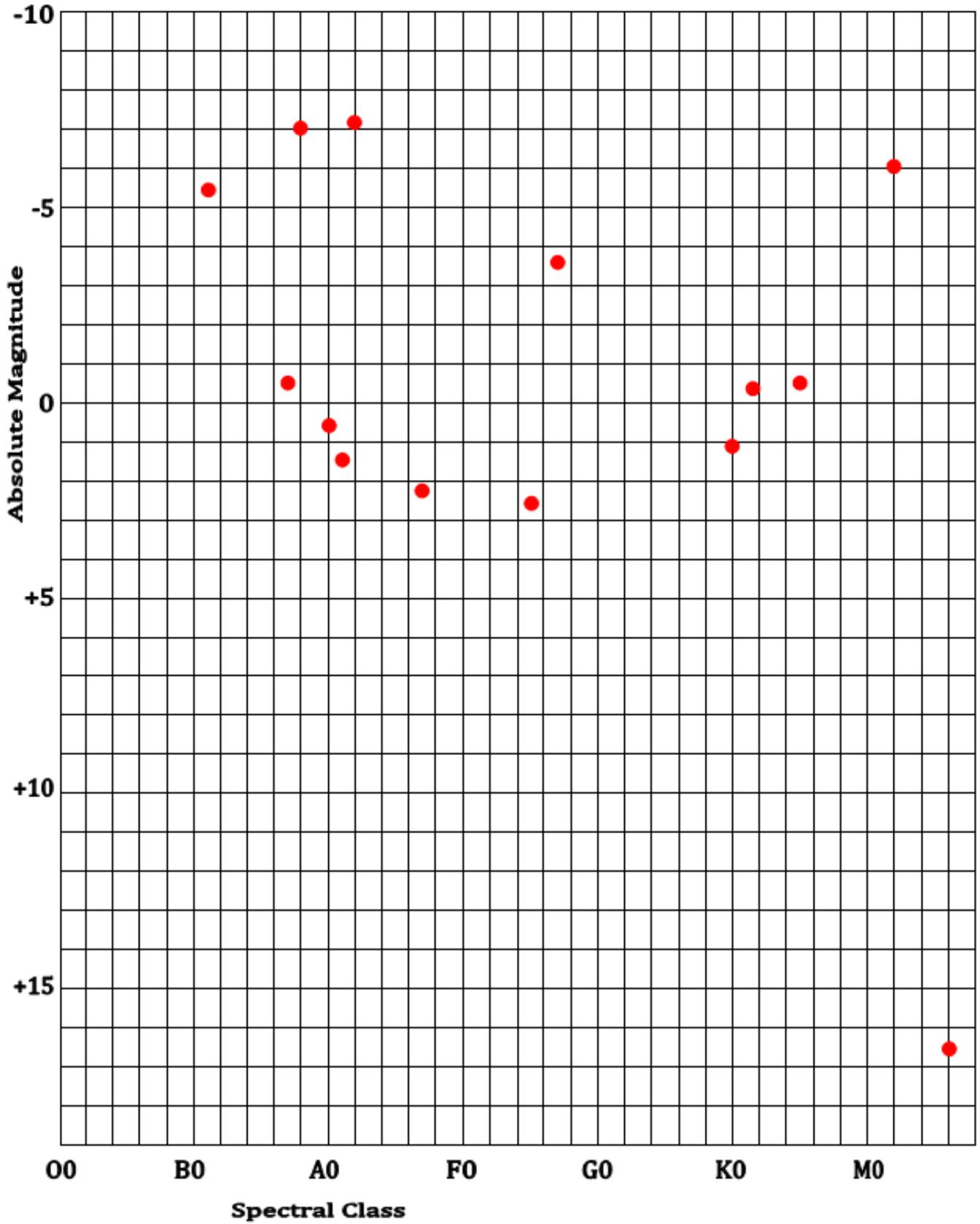
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Section IIb: Fill in the data table and plot the stars on the H-R diagram. (28 pts total)

Star	Apparent Mag.	Distance (LY)	Spectral Class	Absolute Mag.
<i>Vega</i>	0.03	25	A0V	0.6
<i>Spica</i>	0.98 (var)	250	B1V	-5.4
<i>Arcturus</i>	-0.04 (var)	36.7	K1.5III	-0.3
<i>Pollux</i>	1.14	34	K0III	1.1
<i>Deneb</i>	1.25	1550	A2I	-7.1
<i>Regulus</i>	1.35	79	B7V	-0.5
<i>Polaris</i>	2.02	430	F7I-II	-3.6
<i>Aldebaran</i>	0.85 (var)	65	K5III	-0.6
<i>Wolf 359</i>	13.5	7.8	M6V	16.6
<i>Rigel</i>	0.11	870	B8I	-7.0
<i>Altair</i>	0.77	16.8	A7V	2.2
<i>Betelgeuse</i>	0.58 (var)	640	M2I	-6.0
<i>Sirius (A)</i>	-1.47	8.6	A1V	1.4
<i>Procyon</i>	0.34	11.4	F5IV-V	2.6

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