Astronomy C
SSSS 2018

Galaxies and Stellar Evolution

Written by Anna1234

School _____

Team # _____

Names _____

_____

Instructions:

1. There are pictures of a number of galaxies in this test. However, as the DSO list for 2019 hasn't been released yet, the questions asked will not require any knowledge of the galaxies themselves.

2. No partial credit will be given. Math questions will have a range of acceptable answers

3. Tiebreaker questions are in the following order:

    a. Section A: #2, 6, 16; Section B: #1, 5, 9; Section C: #5b, 11, 14

4. **Constants that will be used throughout the test:**

    a. *1 Parsec = 3.1 x 10^{16} meters*

    b. *Mass of the sun = 1.989 x 10^{30} kg*

    c. *Hubble's Constant = 65 km/s/Mpc*

    d. *Absolute Magnitude of Type 1a supernova = -19.3*

Section A: Pseudo-DSOs

M87

M87 has an active galactic nucleus (AGN).

1. Briefly explain what an AGN is and what is thought to cause it.

2. In 1999, a relativistic jet of matter beaming out from the center of this galaxy was measured to be moving much faster than the speed of light. What is the name of this phenomenon?

3. The M in "M87" signifies which classification catalog?

Pinwheel Galaxy

4. Using Hubble's Classification Scheme, classify this galaxy

5. The pinwheel galaxy is known for having a high number of HII regions...
   a. HII regions are also known as what 2 different categories of nebulas.?
   b. HII regions are ionized by stars of which spectral class?

6. SN 2011fe is a type 1a supernova that occured in the pinwheel galaxy. If the peak apparent magnitude of the supernova was 9.9, calculate how far away SN 2011fe occured in megaparsecs.

Sombrero Galaxy

7. There are a large number of global clusters in the sombrero galaxy...
   a. Do global clusters typically reside in the disc or halo of galaxies?
   b. What population of star typically resides in a global cluster?
   c. There are actually two types of global clusters based on the periods of RR Lyrae stars. These two types are known as _____ groups. (fill in the blank)
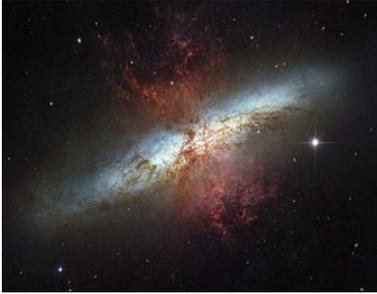
M49

8. Given that this galaxy is 17.14 Mpc away, calculate its redshift

9. M49 is a "LINER" galaxy.
   a. What does LINER stand for?
   b. Name two possible sources for a LINER

Section A: Pseudo-DSOs

M82

10. Tidal forces between the M82 and its neighbor, M81, has caused the creation of a starburst core...
    a. Briefly define what a starburst region is
    b. Explain what effect a starburst region has on the lifetime of a galaxy

11. Given that M82 has a recessional velocity of 203 km/s, and its starburst core has a physical diameter of 600 pc, calculate the angular diameter of the starburst core in arcseconds


Mice Galaxies

The Mice Galaxies are a pair of spiral galaxies in the process of merging! Questions 12-14 will refer to the general process of galaxy mergers.

12. A major merger between two spiral galaxies results in what kind of galaxy?

13. A merge between two gas rich galaxies results in what type of merger?

14. A merge between two gas poor galaxies results in what type of merger?

Extinction Curve of the Milky Way
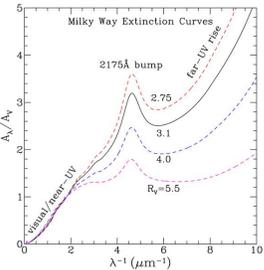
15. Does interstellar extinction cause objects to appear redder or bluer?

16. On this curve, there is a "bump" at 2175 Å. What region of the electromagnetic spectrum does 2175 Å fall under ?


Crab Nebula
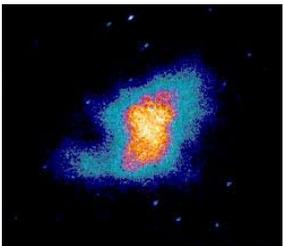
17. What wavelength was this image taken in?

18. The benefit of using the aforementioned wavelength is that it implies that the pular at the center of the nebula is heating up electrons. These electrons are heated and accelerated out from the pulsar in a process known as _____ radiation.

BONUS!

19. This illustration (also shown on the front page) depicts the collision of two galaxies that is expected to occur in 4 billion years. Name the *two* galaxies that are depicted.
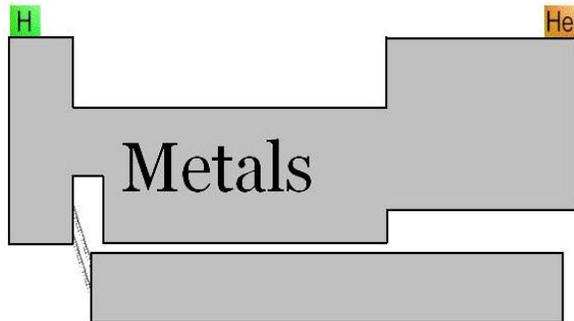
Section B: Stellar Evolution & Other

Hertzsprung-Russell Diagram
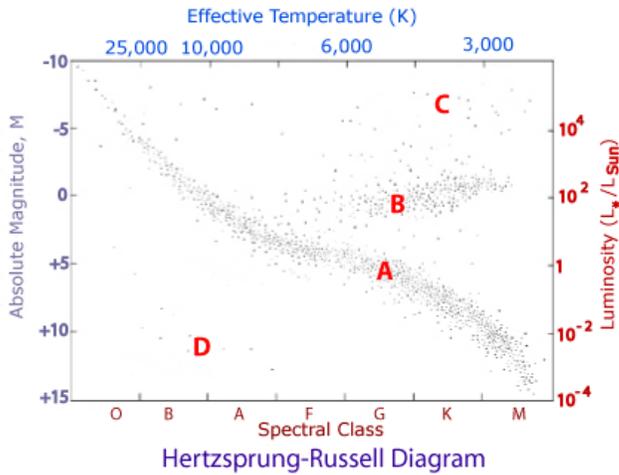
Given the letters placed on the HR Diagram, the star at which letter would...

1. Have the largest radius

2. Have the highest surface temperature

3. Have the highest luminosity

4. Our sun be located at

The Astronomers' Periodic Table of Elements

Questions 5- 6 will refer to metallicity of stars.

5. Would low metal content make a star appear to be redder or bluer?

6. If a star's Fe/H ratio is +0.5

   a. Would it have a high or low metallicity?

   b. What population star would it be?

This is the lightcurve of SN 2011fe, a type 1a supernova

SN 2011fe
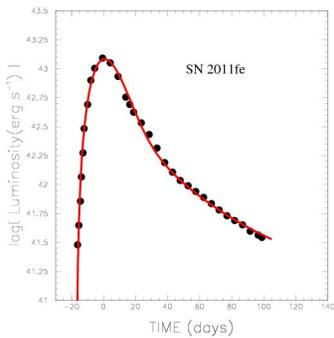
7. The radioactive decay of which element keeps supernovae hot enough to radiate light? (you must specify which isotope!)

8. Type 1a supernovae have a constant absolute magnitude. Why is this useful to astronomers?

9. There are two scenarios that result in the creation of a 1a supernova. Identify and explain *one* of the two scenarios

Section B: Stellar Evolution & Other

Miscellaneous Short Answer Questions:

10. What causes a planetary nebula to "fade" away?

11. Why aren't neutron stars shown as a section on the HR diagram?

12. Why don't high-mass stars fuse elements heavier than iron in their core

Section C: Graphs and Theory

Given the radial velocity curve:

1. Calculate the recessional velocity of the Star A in km/s

2. Calculate the orbital period of this binary system in days

3. Given that the separation between star A and B is 1.496 x 10^{12} meters, calculate the total mass of the *system* in solar masses.

4. Based on the graph (no calculations!), which Individual star is more massive, star A and star B? Briefly explain your reasoning.
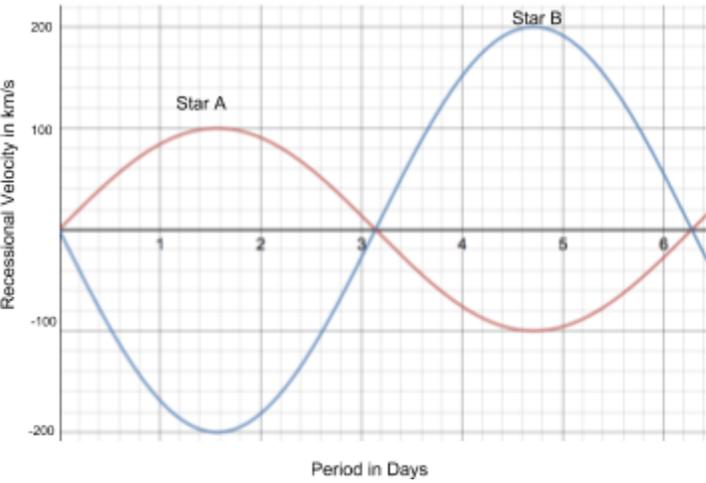
Given the following generic rotation curve of a galaxy:
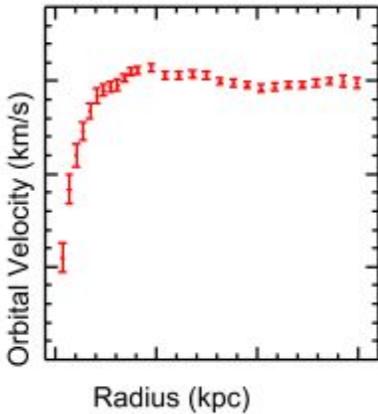
5. The graph begins to flatten as the radius from the center of the galaxy increases...

   a. Briefly explain how is this contrary to what Newton's Law of gravity predicts the graph should look like

   b. Briefly explain the modern theory that supports the shape of this graph

6. If a star is orbiting the center of a galaxy with a mass of 10^{11} M$\odot$ at a radius of 15 kpc, calculate its orbital velocity in km/s

Given the following light curve of a cepheid,
*Assume that the period-magnitude relationship for cepheids is* $M = -1.43 - [2.81 \times log(p_{days})]$

7. Determine its period in days

8. Determine its apparent magnitude

9. Determine how far way it is in parsecs

10. Name the astronomer who discovered the cepheid period-magnitude relationship
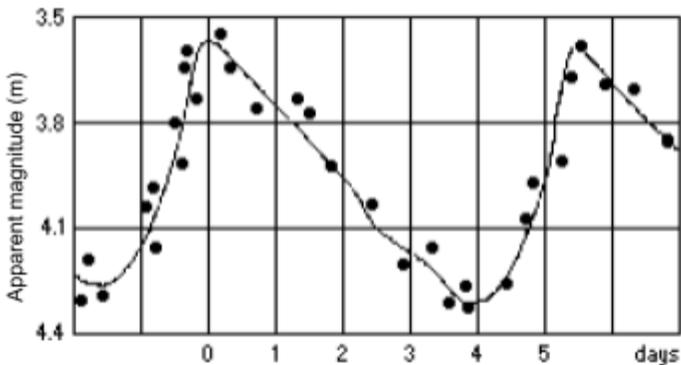
Section C: Graphs and Theory

Sgr A* is the Supermassive Black Hole that is thought to be at the center of the milky way. Assume that Sgr A* has a velocity dispersion of σ = 75 km/s

11. Determine the mass of Sgr A* in kg

12. Determine the Schwarzschild Radius of Sgr A* in meters.

13. Calculate the tidal acceleration on person with a height of 1.5 m falling into Sgr A*
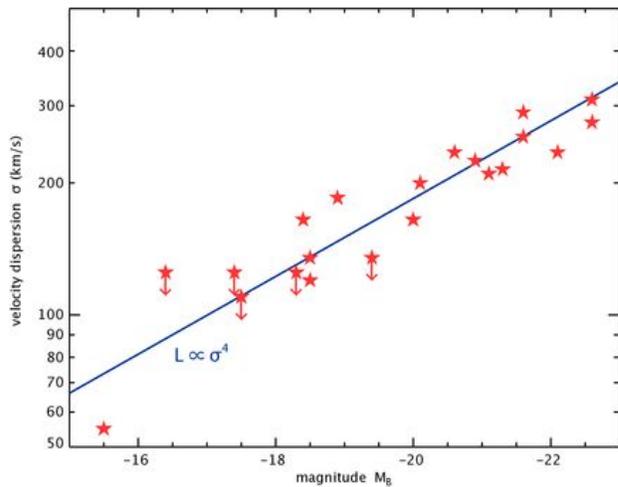
Questions 4-6 are based on the graph to the left:

14. The graph displays a relation between absolute magnitude and velocity dispersion in elliptical galaxies. What is this relation known as?

15. What is the velocity dispersion of an elliptical galaxy with an absolute magnitude of -20.5?

16. What is the kinetic energy of an elliptical galaxy with a constant density, a mass of 4.8 x 10^{42} kg and an absolute magnitude of -20.5
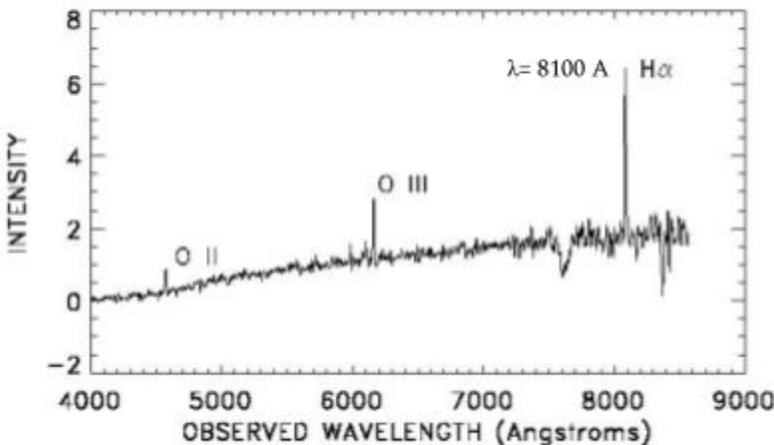
Questions 7-9 are based on the graph to the left:
The graph is a spectrum of a galaxy. The rest wavelength of Hα is 6562.8 Å

17. Calculate the redshift of the galaxy

18. Calculate the recessional velocity of the galaxy in km/s

19. Calculate the distance the galaxy in Mpc

20. Given that Hubble's constant is 65 km/s/Mpc, estimate the age of the universe in years