

ASTR 102 — Mid-term Exam

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100 points total, 50 minutes

Please read all questions **carefully**, and use the marks for each question as a guide to how much material is required. Answer all questions on these sheets, using the backs if necessary.

The speed of light is 3×10^8 m/s (which is in SI units), and one parsec is 3.09×10^{16} m. You may use a calculator.

Name _____

Student Number: _____

Score

- I. /30
- II. /40
- III. /15
- IV. /15

I. SHORT ANSWER QUESTIONS (30 points total; use the backs of pages if necessary)

1. (5 points) By what factor is an 11th magnitude star fainter than a 1st magnitude star?

2. (10 points)

(a) What is the Doppler effect, and why is it important to astronomers?

(b) In the spectrum of the bright star Rigel, the spectral line $H\alpha$ has a wavelength of 656.33 nm. At rest in the laboratory this line has a wavelength of 656.28 nm. Is Rigel coming toward us or moving away from us? At what speed?

3. (10 points)

- (a) Suppose you brought together a proton and an anti-proton. What would happen and how much energy would result? (Take the mass of a proton to be 1.7×10^{-27} kg, and if you stick to SI units the energy will come out in Joules).
- (b) Now suppose you brought together a 100 kg hockey player and an anti-proton. What would happen, and how much energy would result?
- (c) Finally, suppose you brought together an electron and an anti-proton. What would happen, and how much energy would result?

4. (5 points) What methods are used to determine the following properties of stars (a few words for each are probably sufficient)?

Surface temperature:

Radial velocity:

Distance:

Rotation:

Diameter:

II. MULTIPLE CHOICE (40 points total: 2 points each, write the *best* answer beside each question.)

_____ 1. Astrology is

- A. the same as astronomy
- B. a highly predictive science, and not just lucky occasionally
- C. able to withstand close scrutiny, and not immediately falsifiable
- D. a clearly-defined set of ideas, and not just a rag-bag of foggy notions
- E. none of the above

_____ 2. A “blackbody” is

- A. invisible
- B. black
- C. white
- D. a colour which depends on its temperature

- _____ 3. Which of the following allows us to determine the radial velocity of a distant object?
- A. Wien's law
 - B. The Stefan-Boltzmann law
 - C. Heisenberg's uncertainty principle.
 - D. Kepler's laws
 - E. Doppler shift
 - F. Stellar parallax
- _____ 4. Which of the following statements about antimatter is **true**?
- A. antimatter is only a theory, we have no evidence that it exists
 - B. antimatter only exists in Earth laboratories; it cannot be made in stars
 - C. antimatter cannot be made in laboratories; we have tried but it just can't be done
 - D. when equal amounts of matter and antimatter meet, they become pure energy
 - E. our telescopes clearly see many antimatter stars in the Milky Way galaxy
- _____ 5. The Sun is a
- A. giant star
 - B. normal star
 - C. satellite
 - D. white dwarf
 - E. planet
- _____ 6. The most abundant element in the Sun is
- A. hydrogen
 - B. helium
 - C. carbon
 - D. ytterbium
 - E. fire
- _____ 7. In the spectrum of a star, there were no traces of helium. This means that
- A. there is most likely no helium anywhere in the star
 - B. all the helium must be in the core of the star; there is none of it in the outer regions
 - C. since helium shows lines only in hot stars, this star must be relatively cool
 - D. since helium is the kind of element that quickly bonds with others, all the helium in this star must be in the form of molecules
 - E. no surprise: no star ever shows any lines of helium
- _____ 8. The motion of a star across the sky (perpendicular to the line of sight) measured over a number of years is called
- A. radial velocity
 - B. Doppler shift
 - C. parallax
 - D. light travel time
 - E. proper motion

- ___ 9. If a star's temperature doubles, but its size stays the same, its luminosity is changed by a factor of
- A. 2
 - B. doesn't change
 - C. 16
 - D. 4
 - E. 1/2
- ___ 10. How many overhead projectors does your instructor normally use? (the 'did you come to class ever?' question)
- A. none
 - B. one
 - C. two
 - D. three
 - E. four
- ___ 11. The most common kinds of stars in the Galaxy
- A. have low luminosity compared to the Sun
 - B. contain mostly carbon
 - C. are much more massive than the Sun
 - D. have diameters thousands of times greater than the Sun's
 - E. contain less than 10% helium (of their total mass)
- ___ 12. 90% of all stars (if plotted on an H-R diagram) would fall into a region called
- A. the supergiant region
 - B. the main sequence
 - C. the white dwarf region
 - D. the horizontal branch
 - E. the twilight zone
- ___ 13. Astronomers must often know the distance to a star before they can fully understand its characteristics. Which of the following properties of a star typically requires a knowledge of distance before it can be determined?
- A. chemical composition
 - B. luminosity
 - C. radial velocity
 - D. temperature
 - E. apparent brightness
- ___ 14. Which of the following is false?
- A. A photon of blue light has more energy than a photon of red light.
 - B. Radio waves and X-rays travel at the same speed.
 - C. Infrared radiation has shorter wavelengths than radio waves.
 - D. Gamma rays are the photons with the highest frequencies.
 - E. Ultraviolet light has a lower frequency than visible light.

- _____ 15. You are an astronomer whose supervisor has just forbidden drinking alcoholic beverages near the observatory. In frustration, you undertake a search for alcohol molecules in space. Where would you be most likely to succeed?
- A. in a binary star system
 - B. in a supernova remnant
 - C. in the surface layers of the Sun, or other star
 - D. in an interstellar cloud of gas and dust
 - E. in a region of ionized hydrogen near an O type star
- _____ 16. Which of the following is necessarily true of two blackbody objects (for example, two stars)?
- A. The hotter one is more luminous.
 - B. The bigger one is more luminous.
 - C. The more massive one is more luminous.
 - D. If they are the same temperature, they are equally luminous.
 - E. None of the above
- _____ 17. When an electron moves from one energy level to another it absorbs or emits a
- A. proton
 - B. neutron
 - C. alpha particle
 - D. ion
 - E. photon
- _____ 18. An astronomer wants to observe a cloud of cold neutral hydrogen, far from any stars. What instrument could she use?
- A. a telescope in space capable of observing X-rays
 - B. an optical spectrometer set up to see the Balmer lines
 - C. a neutrino detector placed far underground
 - D. a radio telescope, tuned to a wavelength of about 21 centimeters
 - E. the Hubble Space Telescope's wide-field camera
- _____ 19. The number 789,000 is closest to ten raised to what power?
- A. third
 - B. fourth
 - C. fifth
 - D. sixth
 - E. seventh
- _____ 20. Which of the following is true of the Sun?
- A. It is comparable in density to water on Earth.
 - B. It emits the predicted flux of neutrinos.
 - C. It will one day become a supernova.
 - D. It is an M star.
 - E. It was once a Red Giant.

III. MATCHING (15 points total. Write the letters beside the numbers, choosing the **best** answer with no repeats)

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|---------|---|-----------|
| ___ 1. | Earth-Sun distance in Astronomical Units | A. 60 |
| ___ 2. | Fraction of stars which are in a binary system | B. 5 |
| ___ 3. | Number of Labs in the course | C. 5800 |
| ___ 4. | Distance of closest planet (in AU) | D. 100 |
| ___ 5. | Wavelength of visible light in nm | E. 0.5 |
| ___ 6. | Temperature of a spectral class F star (in Kelvin) | F. 4.6 |
| ___ 7. | Number of arc minutes in a degree | G. 4 |
| ___ 8. | Number of magnitudes for a factor of 10 in distance | H. 1.0 |
| ___ 9. | Age of the solar system in billions of years | I. 3600 |
| ___ 10. | Distance in pc of an object with parallax of 0.01 arc seconds | J. 10,000 |
| ___ 11. | Temperature of a spectral class K star (in Kelvin) | K. 500 |
| ___ 12. | Number of arc seconds in a degree | L. 0.0 |
| ___ 13. | Temperature of the surface of the Sun (in Kelvin) | M. 4200 |
| ___ 14. | Number of minutes in a lecture | N. 1000 |
| ___ 15. | Peak wavelength (in nm) for a 2900 Kelvin star | O. 50 |

IV. DISCUSSION (15 points)

2 stars occupy a similar position on the Hertzsprung-Russell diagram: star A is a protostar on its way to the Main Sequence; star B is a post-Main Sequence star on its way up the giant branch. What properties of these stars are approximately equal? How are they fundamentally different? Can you think of some ways that you could tell them apart?