

ASTR 101 — Midterm 2

Introduction to Astronomy — Spring 2026

San Diego State University

Instructor: Dr. Anna Rosen

Name: _____

Date: Monday, April 20, 2026

Instructions:

- **25 questions, 50 minutes.** Choose the single best answer (A–D) for each question.
- A scientific or graphing calculator is allowed but should not be needed — all quantitative questions are designed for ratio reasoning.
- An **equation sheet** is provided separately. You may not use notes or textbooks.
- Mark your answers clearly. Ambiguous marks will not receive credit.

1. A region of hot, ionized hydrogen glowing near a young O-type star is best classified as a(n):

- A. Emission nebula (H II region)
- B. Reflection nebula
- C. Dark nebula
- D. Planetary nebula

Answer: _____

2. In about 5 billion years, the Sun will end its life as:

- A. A supernova, scattering its outer layers across interstellar space
- B. A black hole
- C. A neutron star
- D. A planetary nebula leaving behind a white dwarf

Answer: _____

3. The Sun continues to shine for billions of years because it:

- A. Burns hydrogen as a chemical fuel, like a giant fireplace
- B. Fuses hydrogen into helium in its core, converting mass to energy via $E = mc^2$
- C. Slowly cools from its formation temperature with no internal energy source
- D. Collects energy from neighboring stars via gravity

Answer: _____

4. A star is (hypothetically) moved to three times its current distance from Earth. Compared to the original, the star's new apparent brightness is:

- A. $3 \times$ as bright
- B. $1/9$ as bright
- C. $1/3$ as bright
- D. $1/27$ as bright

Answer: _____

5. When a main-sequence star exhausts the hydrogen in its core, the *immediate* next phase is:

- A. The star immediately explodes as a supernova, ejecting its outer layers
- B. The star rapidly contracts directly into a white dwarf
- C. The inert helium core contracts and heats up; hydrogen shell burning ignites and outer layers expand into a red giant
- D. Fusion stops entirely and the star cools into a black dwarf within a few million years

Answer: _____

6. Star A and Star B have identical radii, but Star A's surface temperature is twice Star B's. Star A's luminosity compared to Star B's is:

- A. $2 \times$
- B. $4 \times$
- C. $8 \times$
- D. $16 \times$

Answer: _____

7. Which of the following stars would end its life as a core-collapse (Type II) supernova?

- A. A $25M_{\odot}$ O-type star
- B. A $1M_{\odot}$ Sun-like star
- C. A $0.5M_{\odot}$ red dwarf
- D. An isolated $0.8M_{\odot}$ white dwarf

Answer: _____

8. A binary system has orbital period 2 years and separation 2 AU. Its total mass is:

- A. $0.5M_{\odot}$
- B. $2M_{\odot}$
- C. $1M_{\odot}$
- D. $4M_{\odot}$

Answer: _____

9. A Sun-like star evolves off the main sequence into a red giant. Its surface temperature decreases from about 6000 K to about 3000 K. Compared to its main-sequence peak, the red giant's peak-emission wavelength is:

- A. Half as long
- B. The same
- C. Four times as long
- D. Twice as long

Answer: _____

10. A black hole with the mass of the Sun has a Schwarzschild radius of about 3 km. The Schwarzschild radius of a $10M_{\odot}$ black hole is approximately:

- A. 3 km
- B. 10 km
- C. 30 km
- D. 300 km

Answer: _____

11. A background star viewed *through* a dusty interstellar cloud appears:

- A. Dimmer and redder
- B. Dimmer and bluer
- C. Brighter and redder
- D. Brighter and bluer

Answer: _____

12. A main-sequence star with 4 times the Sun's mass has a luminosity of approximately:

- A. $4L_{\odot}$
- B. $16L_{\odot}$
- C. $256L_{\odot}$
- D. $128L_{\odot}$

Answer: _____

13. For a nearby star, which chain correctly links a *direct observation* to a derived *luminosity*?

- A. Measure luminosity directly → apply Stefan-Boltzmann → temperature
- B. Measure parallax → distance; measure apparent brightness; apply the inverse-square law → luminosity
- C. Measure mass directly → apply the mass-luminosity relation → luminosity
- D. Measure color → apply Wien's law → luminosity

Answer: _____

14. A red giant has a cool surface temperature (~ 3000 K) yet is among the most luminous stars in the sky. The best physical explanation is:

- A. Red giants are extremely dense, boosting their emission efficiency
- B. Cool stars emit more infrared, which dominates total luminosity measurements
- C. Red giants have enormous radii, so their luminosity is large even at a low surface temperature
- D. Red giants absorb and re-emit energy supplied by nearby stars

Answer: _____

15. A $4M_{\odot}$ main-sequence star will exhaust its core hydrogen in approximately:

- A. 40 Gyr
- B. 10 Gyr
- C. 0.003 Gyr
- D. 0.3 Gyr

Answer: _____

16. In which layer of the Sun is energy transported primarily by the bulk motion of hot plasma rising and cool plasma sinking?

- A. Convective zone
- B. Radiative zone
- C. Core
- D. Corona

Answer: _____

17. A star evolving *off* the main sequence moves toward which region of the H-R diagram?

- A. Lower-left (hot, dim)
- B. Down the main sequence toward lower mass
- C. Lower-right (cool, dim)
- D. Upper-right (cool, luminous)

Answer: _____

18. Two stars appear equally bright to the eye. Star A has a parallax of 0.1 arcsec; Star B has a parallax of 0.01 arcsec. The best conclusion is that:

- A. Both stars have the same intrinsic luminosity
- B. Star B is intrinsically about $100 \times$ more luminous than Star A
- C. Star A is intrinsically about $100 \times$ more luminous than Star B
- D. The two stars must have the same temperature

Answer: _____

19. The Chandrasekhar limit ($\approx 1.4M_{\odot}$) defines:

- A. The maximum mass of a main-sequence star
- B. The minimum progenitor mass for any supernova
- C. The maximum mass a white dwarf can have before electron degeneracy pressure can no longer support it
- D. The typical mass of a neutron star

Answer: _____

20. If the Sun were instantaneously replaced by a $1M_{\odot}$ black hole (same mass), the Earth's orbit would:

- A. Be unchanged, because gravitational force at distance depends only on mass
- B. Spiral inward and be consumed within a year
- C. Expand to twice its current size
- D. Become chaotic and eject Earth from the Solar System

Answer: _____

21. The main sequence on the H-R diagram is best interpreted as:

- A. A track a single star follows as it ages, moving from upper-left to lower-right
- B. A region populated only by young, recently-formed stars
- C. The set of evolutionary stages every star passes through in order
- D. A snapshot of stars of different masses simultaneously fusing hydrogen in their cores

Answer: _____

22. The iron core of a massive evolved star cannot sustain the star against gravitational collapse because:

- A. Iron atoms chemically repel one another
- B. Iron is too dense to ignite
- C. Iron fusion *absorbs* rather than releases energy (binding energy per nucleon peaks near iron)
- D. Magnetic fields prevent iron fusion

Answer: _____

23. Elements heavier than iron are primarily produced:

- A. During steady hydrogen-to-helium fusion in main-sequence stars
- B. Inside white dwarfs through slow carbon-oxygen fusion
- C. In supernova explosions, where extreme temperatures and densities forge heavy elements
- D. In red-giant cores during stable helium burning

Answer: _____

24. A cluster contains many G-type stars still on the main sequence, but no O-type stars. This is best interpreted as:

- A. The cluster is old enough that all O stars have evolved off the main sequence
- B. O stars were never formed in this cluster
- C. G stars have brighter absolute magnitudes than O stars, so O stars are lost to background
- D. The cluster is too far away for O stars to be detected

Answer: _____

25. When two neutron stars spiral together and merge, astronomers can detect:

- A. Only electromagnetic light — the gravitational waves would be too faint to register
- B. Both gravitational waves from the inspiral and electromagnetic light from the colliding matter
- C. Only gravitational waves — the collision itself produces no electromagnetic radiation
- D. Neither — mergers of two neutron stars have not yet been observed directly

Answer: _____

End of exam. Please check that you have answered all 25 questions.