Multiple Choice. *In the blanks provided before each question write the letter for the phrase that best answers the question or completes the thought and fill in the corresponding area on the computer graded sheets with a number 2 lead pencil.*

**B 1.** The incident light from the Sun measured at the surface of the Earth in Watts per square meter is called:

A. The Maunder Minimum
B. The Solar Constant
C. The Universal Constant
D. The Hubble Constant
E. The Sunspot Cycle

**C 2.** What inevitably forces a star like the Sun to evolve away from being a main sequence star?

A. the core loses all its neutrinos, so all fusion ceases
B. the carbon detonation explodes it as a type I supernova
C. the core becomes 100% helium, while the hydrogen burning shell expands
D. the core begins fusing iron
E. the star uses up its entire supply of hydrogen

**B 3.** What is the single most important characteristic in determining the course of a star’s evolution?

A. absolute brightness
B. mass
C. density
D. surface temperature
E. distance

**E 4.** Which of the following is NOT a way that terrestrial and jovian planets differ?

A. Terrestrials are much smaller in size than the jovians.
B. Jovians are less dense than any of the terrestrials.
C. Jovians have many more satellites than do terrestrials.
D. Jovians have rings, terrestrials do not.
E. Jovian orbits are more eccentric than terrestrials, and farther off the ecliptic.
5. Three different star clusters with different ages are plotted in diagrams A, B, and C in the figure below. Arranging the diagrams in order from *youngest to oldest* cluster, the proper order should be:
   A. B, C, A  B. C, A, B
   C. C, B, A  D. B, A, C
   E. A, B, C

6. Which of the following apparent magnitudes is the brightest?
   A. +4.8  B. +9.2  C. −1.4  D. +25.7  E. −23

7. The absolute magnitude of a star is:
   A. its intrinsic luminosity in Watts
   B. its apparent magnitude if it were seen from a distance of ten parsecs
   C. the “wobble” measured due to the gravitational pull of its planets on the star in km/s
   D. its apparent brightness in Watts per unit area
   E. the maximum mass the star will achieve in its lifetime in kg

From the list below of Interstellar Medium constituents, find the best matches for the phrases that follow. List items can be used more than once.

A. Dust  B. H₂  C. CO  D. HI  E. HII

8. the primary constituent of large complexes called Giant Molecular Clouds

9. absorbs or scatters light whose wavelength is shorter than the typical size of its particles

10. makes up hot, ionized hydrogen regions

11. seen at radio wavelengths because of ground state electrons flipping their spin over to be antiparallel to the nuclear spin

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A 12. The “standard candle” method for determining distances involves:
   A. comparing the apparent brightness of an object with its intrinsic luminosity
   B. comparing the proper motion of a star with its true space motion
   C. measuring the apparent shift of an object with respect to the background stars
   D. comparing the spectral type of a star with its color
   E. measuring the mass and radius of an object

B 13. Mass transfer in binaries occurs when one giant swells to reach the:
   A. Hayashi Track
   B. Herbig-Haro Limit
   C. Chandrasekhar Limit
   D. Cassini Division
   E. Roche Lobe

D 14. A typical protostar may be several thousand times more luminous than the Sun. What is the source of this energy?
   A. the ionization of the gas as it heats up
   B. nuclear fusion in its core
   C. chemical combustion of hydrocarbons
   D. from the release of gravitational energy as the protostar continues to shrink
   E. from nearby hot stars or supernovae that have initiated the star formation process

A 15. According to the new 2006 definition of a planet, Pluto is now a dwarf planet. What is the main characteristic of Pluto for which it is no longer considered a true planet?
   A. it has not cleared out its immediate neighborhood of smaller objects through gravity
   B. it is too small to have a spherical shape
   C. it has too eccentric of an orbit
   D. it is too far away from the Sun
   E. it is smaller than some other Kuiper Belt Objects which are considered planets

From the list below of H-R Diagram locations, find the best matches for the phrases that follow. List items can be used more than once.
A. Main Sequence       B. Red Giant Branch        C. Horizontal Branch
D. Planetary Nebula - White Dwarf Phase   E. Asymptotic Giant Branch

A 16. where stars spend most of their life
B 17. only shell hydrogen burning while the star expands and reddens
A 18. core hydrogen burning
B 19. only shell helium and shell hydrogen burning while the star expands and reddens
D 20. where electron degeneracy supports the star which cools down into a dark “ash”
C 21. core helium and shell hydrogen burning
22. An iron core cannot support a star because:
   A. iron cannot fuse with other nuclei to produce energy
   B. iron is in the form of a gas, not a solid, in the center of a star
   C. iron has poor nuclear binding energy
   D. iron supplies too much pressure
   E. iron is the heaviest element, and sinks upon differentiation

23. Which of the following statements about star clusters is NOT true?
   A. the turn-off point on the H-R diagram will be lower down the main sequence for older clusters
   B. open clusters have as many members as globular clusters, but spread their stars out over a much larger volume
   C. we currently observe only formation of open, not globular clusters, near us
   D. all stars in a cluster have the same age and same composition
   E. for young clusters, almost every star is still on the main sequence

24. Which of the following statements is NOT true about the Sun?
   A. it will end its life as a supernova
   B. it is a main sequence star
   C. it will burn hydrogen into helium for approximately another 5 billion years
   D. it will evolve into a red supergiant that likely will eventually engulf the Earth
   E. it has spectral type G2V

25. The detection of most extra-solar planets is done by:
   A. noting Doppler shifts due to their gravitational influence on their star’s motion
   B. imaging them in the infrared with the new Spitzer Space Telescope
   C. imaging them with the Hubble Space Telescope and using an occulting disk over their star
   D. seeing the drop in light as they transit their star’s disk
   E. receiving radio signals from them

26. If the initial interstellar cloud for star formation has a mass sufficient to form hundreds of stars, how do individual stars form from it?
   A. a supernova blows the cloud up and dissipates the majority of the gas
   B. one star forms and the rest of the matter goes into making planets, moons, and other objects of a solar system
   C. one star forms at its center and blows the rest of the matter back into space
   D. the cloud is disrupted by rotation so that it reduces its mass down to that of a typical star
   E. the cloud fragments into smaller clouds and forms many stars at one time

27. Which of the following is NOT a feature seen at the surface of the Sun?
   A. granules
   B. auroras
   C. flares
   D. prominences
   E. sunspots
E 28. Beyond our own solar system, the planets found to date have tended to be:
   A. Kuiper Belt Objects, far from the glare of their suns
   B. large jovian-type planets, at far distances from stars like our Sun
   C. imaginary, with no present proof that they really exist
   D. terrestrial-type planets, very close to their star, and transiting its disk
   E. large jovian-type planets, with orbits more like terrestrial planets

D 29. A cloud fragment too small to form a star becomes:
   A. a red giant  
   B. a Herbig Haro object
   C. a black hole  
   D. a brown dwarf
   E. a T Tauri object

From the list below, find the best matches for the phrases that follow. List items can be used more than once.
A. Supernova Type I  
B. Supernova Type II  
C. Planetary Nebula  
D. Spectroscopic Binary  
E. Nova

B 30. It is the final stage of evolution in a star that forms an iron core
A 31. It has almost no hydrogen or helium lines in its spectrum
E 32. Part of a mass-transfer binary, it results from nuclear ignition in accretion disk of the transferred material
C 33. It leaves behind an expanding shell of ionized gas surrounding a white dwarf
C 34. It is the final stage of evolution for a solitary low-mass star

D 35. Which type of binary can have their sizes measured directly by photometry?
   A. spectroscopic  
   B. astrometric
   C. visual  
   D. eclipsing
   E. virtual

B 36. The pattern of rising hot gas convection cells all over the photosphere is called:
   A. prominences  
   B. granulation
   C. convective projections  
   D. sunspots
   E. filaments
True/False: In the blanks provided before each question write whether the following statements are True (T) or False (F). Fill in A for True and B for False on your score sheet.

F 37. The proper motion of a star is its true three-dimensional velocity through space.
F 38. Jupiter is considered to be a brown dwarf, since it does glow dull red.
T 39. While the Sun’s volume is over a million earths, it is not as dense as the Earth.
T 40. The birth of stars is a battle between gravity and radiation pressure.
F 41. The visible part of the solar photospheric spectrum is dominated by thousands of emission lines.
F 42. Massive stars may form quickly, but last a lot longer on the main sequence than does our sun.

Star A is an O-type main sequence star and Star B is a K-type main sequence star.

Indicate whether the following statements about these stars are True (T) or False (F).
T 43. Absorption lines are stronger and abundant in the spectrum of Star B than Star A.
F 44. Star A will be on the main sequence longer than Star B.
T 45. Star A is more massive than Star B.
F 46. Star A took longer to contract and arrive on the main sequence than Star B.
T 47. Star B is burning hydrogen into helium.
F 48. Star A is redder than Star B.
T 49. Star A is more luminous than Star B.
F 50. Star A is burning helium into carbon.