1. Interstellar gas is composed mainly of
   A) some hydrogen, but mainly carbon dioxide.
   B) 90% hydrogen, 9% helium by weight.
   C) ammonia, methane, and water vapor.
   D) only hydrogen.
   E) 10% hydrogen, 90% helium by numbers of atoms.

2. What effect does even thin clouds of dust have on light passing through them?
   A) It dims and reddens the light of all more distant stars.
   B) Its motion causes all light to be red shifted as it passes through these clouds.
   C) Even a little can completely block all light, such as the Horsehead Nebula.
   D) Its motion causes the light of stars beyond to twinkle.
   E) The light that passes though them is blue shifted due to the cloud's approach.

3. Which statement about the dark nebulae is true?
   A) They block the vast majority of radio waves from our Galaxy.
   B) They can be penetrated only with longer wavelengths such as radio and infrared.
   C) Hydrogen and helium are the chief absorbing and scattering agents.
   D) They can be penetrated only with shorter waves, such as UV and x-ray.
   E) They comprise the majority of the mass of the Galaxy.

4. Some regions along the plane of the Milky Way appear dark because
   A) stars in that region are hidden by interstellar gas.
   B) many black holes absorb all light from those directions.
   C) stars in that region are hidden by dark dust particles.
   D) there are no stars in these areas.
   E) many brown dwarfs in those areas absorb light which they turn into heat.

5. Due to absorption of shorter wavelengths by interstellar dust clouds, distant stars appear
   A) bluer.
   B) brighter.
   C) to have a higher radial velocity.
   D) larger.
   E) redder.

6. Which statement is true about the interstellar medium?
   A) Gas obscures the light from distant stars.
   B) We know more about the gas than the dust.
   C) Dust blocks the longest electromagnetic wavelengths.
   D) Dust is spread uniformly through the galaxy.
   E) Gas contains a lot of carbon atoms.

7. Spectra of interstellar gas show it has the same basic composition as
   A) the Martian polar caps.
   B) Earth's atmosphere.
   C) interstellar dust.
   D) stars.
   E) asteroids.

8. Emission nebulae like M-42 occur only near stars that emit large amounts of
   A) microwaves.
   B) visible light.
   C) ultraviolet radiation.
   D) x-rays and gamma rays.
   E) infrared heat.

9. What is the primary visible color of an emission nebula?
   A) blue from the scattering of light off the tiny molecules
   B) yellow because of dust.
   C) red due to ionized hydrogen atoms
   D) black, for the dust associated with them absorbs all visible light
   E) colorless, for hydrogen is crystal clear

10. The density of interstellar dust is very low, yet it still blocks starlight because
    A) the dust particles are about the same size as the light waves they absorb.
    B) it is so cold it absorbs higher energy photons.
    C) ice particles reflect all light back toward their stars, not toward us.
    D) there is 100 times more opaque gas than dust present in the ISM.
    E) the dust particles are irregular in shape.

11. The gas density in an emission nebula is typically a few _____ particles per cc.
    A) hundred
    B) thousand
    C) million
    D) dozen
    E) hundred thousand

12. What two things are needed to create an emission nebulae?
    A) hydrogen fusion and helium ionization
    B) cool stars and much interstellar dust
    C) hot stars and interstellar gas, particularly hydrogen
    D) interstellar gas and dust
    E) hydrogen gas and carbon dust

13. A large gas cloud in the interstellar medium that contains several type O and B stars would
    A) appear to us as
    B) bright blue.
    C) a dark patch against a bright background.
    D) a reflection nebula.
    E) an emission nebula.
    F) a dark nebula.

14. Which of these is not a consequence of dust in the interstellar medium?
    A) reddening of stars' light that passes through the dust
    B) blue reflection nebulae around the Pleiades
    C) terrestrial planets like our own
    D) the dark nebulae that block 90% of the Milky Way from us visually
    E) red light from the emission nebulae

15. The most common molecule in a molecular cloud is
    A) ammonia, with three hydrogens attached to a nitrogen.
    B) molecular hydrogen, made of two H atoms.
    C) methane, with four hydrogens around a hydrogen.
    D) water, with two hydrogens around an oxygen.
    E) carbon monoxide, with one carbon and an oxygen.

16. Why are dark dust clouds largely misnamed?
    A) Dust clouds do radiate energy, but not as much light as the stars do.
    B) It is ice, not dust, which make them look dark.
    C) The cloud is an illusion, for the dust is evenly distributed around the Galaxy.
    D) They contain much more gas than dust.
    E) All of the above are correct.

17. Complex molecules in the interstellar medium are found
    A) uniformly throughout the disk of the Galaxy.
    B) primarily in the dense dust clouds.
    C) scattered evenly throughout the universe, a product of the Big Bang itself.
    D) on the surfaces of the coolest class K and M stars only.
    E) only around the supergiant stars like Betelguese that make their heavy atoms.

18. What information does 21 cm radiation provide about the gas clouds?
    A) their temperature
    B) their density
    C) their distribution
    D) their motion
    E) all of these

19. Neutral hydrogen atoms are best studied from their energy given off as
    A) 21 cm waves in the radio region.
    B) 121.3 nm as Lyman alpha emission in the UV.
    C) .2 nm as x-rays.
    D) red hydrogen alpha emission, at 656.3 nm.
    E) Neutral hydrogen gives off no detectable radiation, since it is cold, not hot.

20. The average temperature of the typical dark dust cloud is about
    A) 6,000 K.
    B) 273 K.
    C) 3,000 K.
    D) 0 K.
    E) 100 K.

21. Interstellar dust clouds are best observed at what wavelength?
    A) visible only
    B) UV and infrared
    C) Radio and x-ray
    D) Radio and infrared
    E) Visible and UV

22. When an electron in H changes its spin from the same to the opposite direction as the proton, it
    A) emits an x-ray photon.
    B) emits a radio wave photon.
    C) absorbs a radio wave photon.
    D) neither emits nor absorbs a photon.
    E) absorbs a visible light photon.

23. A newly formed protostar will radiate primarily at which wavelength?
    A) radio
    B) visible light
    C) infrared
    D) ultraviolet
    E) x-ray

24. During a protostar's T Tauri phase, it
    A) begins a period of reduced activity.
    B) expands dramatically.
    C) lies on the main sequence.
    D) changes its spin direction.
    E) may develop very strong winds.

25. What is the critical core contraction temperature for ZAMS stars?
    A) 3,000 K
    B) 5,800 K
    C) 1 million K
    D) 15 million K
    E) 100 million K

26. Which statement about the stages of starbirth is false?
    A) By stage 3, the star has formed a photosphere.
    B) nuclear reactions begin in the core by stage 4.
    C) The T-Tauri wind is prevalent in stage 5.
    D) By stage 7, the star has reached the main sequence.
    E) At stage 1, only the cloud exists.

27. On an H-R diagram, a protostar would be
    A) above and near the upper left of the main sequence.
    B) on the main sequence at the extreme lower right.
    C) below and to the left of the main sequence.
    D) below and near the right side of the main sequence.
    E) above and to the right of the main sequence.

28. The single most important determinant of the temperature, density, radius, luminosity, and pace
    A) of evolution of a protostar is its
    B) molecular composition.
    C) magnetic field.
    D) mass.
    E) spin.
    F) chemical composition.

29. A cloud fragment too small to collapse into a main sequence star becomes a
    A) pulsar.
    B) planet of another star.
    C) white dwarf.
    D) brown dwarf.
    E) T Tauri object.

30. How long does it take an M class star to reach the main sequence, compared to a solar type star?
    A) longer than the age of the Galaxy
    B) a tenth as long
    C) about the same, 30 million years
    D) about twice as long
    E) about twenty times longer

31. A fragment of a collapsing gas cloud that comes to equilibrium with a central temperature of 4 million K will become a
    A) brown dwarf
    B) black dwarf
    C) black hole.
    D) stage 1 protostar.
    E) T Tauri star.

32. All globular clusters in our Milky Way are about how old?
    A) around ten billion years old
    B) less than a million years
    C) a variety of ages, from newly born to twenty billions years old
    D) ten-fifty million years old
    E) one to three billion years old

33. What are the characteristics of an open cluster?
    A) no stars left on the main sequence, but millions of white dwarfs
    B) a few hundred stars, most still on the main sequence
    C) old age and tens of thousands of stars
    D) a star forming region, hundreds of light years across, with many blue MS stars
    E) millions of stars, both young and old, spread out over 100,000 ly.

34. Which is characteristic of globular star clusters?
    A) a mix of old and young stars, about 100,000 ly across
    B) no remaining MS stars, but millions of white dwarfs
    C) old age and hundreds of thousands of stars, only about 30 ly wide
    D) bright blue main sequence stars, and thousands of them
    E) only brown dwarfs in a yellow ball 100 ly across

35. Which of these would typically be the brightest star in a young open cluster?
    A) M3Ia
    B) B1V
    C) G2V
    D) A2Ib
    E) K3II

36. Why are star clusters ideal "laboratories" for stellar evolution?
    A) Their stars are all about the same mass and temperature.
    B) Like our Sun, they lie in the plane of the Milky Way.
    C) The combined light of all the stars makes them easier to see.
    D) Their stars are all about the same age, composition, and distance from us.
    E) Their stars are all the same composition and stage in evolution.

37. Most stars in our part of the Galaxy are formed
    A) in globular clusters of millions of stars.
    B) in open clusters of a few dozen.
    C) alone.
    D) in a singular event just after the Big Bang.
    E) in associations of thousands of stars across a spiral arm of the Galaxy.

38. Which of these would be the brightest star in an ancient globular cluster?
    A) O3
    B) B3
    C) K3
    D) M5
    E) A4