1. Rank in decreasing order of the likely reliability of the information provided
   a. Web pages, peer-reviewed articles, main-stream media
   b. Peer-reviewed articles, main-stream media, web pages
   c. All three of these types of sources are about equally reliable
   d. Main-stream media, web pages, peer-reviewed articles
   e. Web pages, main-stream media, peer-reviewed articles

2. Sunspots are
   a. regions where strong absorption lines reduce the output of the sun
   b. regions where a strong magnetic field interferes with the outward transport of energy
   c. bodies above the surface of the sun that block some of its light
   d. where cool bodies have recently fallen into the sun
   e. where solar storms bring cooling flows

3. If we have a container of hydrogen gas sitting in a laboratory on Earth, why doesn't it turn into helium?
   a. because trace elements are required
   b. because the temperature and pressure are too low
   c. because the hydrogen needs other isotopes
   d. because an electric spark is needed
   e. it will become helium if you wait long enough

4. Which two things are needed to determine an object's distance from the Earth if it is too distant to use trigonometric parallaxes?
   a. velocity and luminosity
   b. velocity and apparent brightness
   c. apparent brightness and luminosity
   d. apparent brightness and size
   e. proper motion and apparent brightness

Here are the properties of three main sequence stars: 1.) Barnard's Star \( T= 3370^\circ K \) \( L=0.005 \ L_{\text{Sun}} \); 2.) Sun \( T= 5800^\circ K \) \( L=1 \ L_{\text{Sun}} \); 3.) Spica \( T=26,000^\circ K \) \( L = 23,000 \ L_{\text{Sun}} \)

5. List these stars in order of decreasing mass.
   a. Spica, Sun, Barnard's Star
   b. Spica, Barnard's Star, Sun
   c. Barnard's Star, Sun, Spica
   d. Barnard Star's, Spica, Sun
   e. Sun, Barnard's Star, Spica

6. A white dwarf does not collapse further because
   a. it is converting H to He
   b. it is converting He to C
   c. its electrons can't be squeezed together any more
   d. it is made of dark matter
   e. of neutron degeneracy

7. Planetary nebulae are
   a. in the process of forming planets
   b. molecular clouds
   c. the ejected outer layers of a dying star
   d. the precursors to black holes
   e. the result of protostars having disks
8. An energy level diagram for an atom is given to the right. Which of the transitions will yield an emission line the farthest to the blue?
   a. 5 – 2
   b. 4 – 2
   c. 3 – 2
   d. 5 – 4 (not drawn)
   e. 4 – 3 (not drawn)

9. We will eventually be able to locate where the Big Bang occurred
   a. by accurate measurements of galaxy velocities and distances
   b. by measuring the redshifts of very distant quasars
   c. using gravitational lenses
   d. by measuring anisotropies on the cosmic background radiation
   e. none of the above

10. One of the reasons the sky is dark at night is
    a. we are in a dark part of the Milky Way
    b. there is a lot of dark matter out there
    c. the Universe is expanding
    d. dust blocks our view in almost every direction
    e. we look up, out of the Milky Way when the earth turns us away from the sun

11. The nuclear force does not dominate interactions between celestial bodies because
    a. it is too weak
    b. it acts only over short distances
    c. it needs magnetic materials to be effective
    d. positive charges largely cancel the effects of negative ones
    e. actually, it does dominate such interactions

12. A "closed" universe is
    a. one that will expand forever
    b. one that will collapse back on itself some long time in the future
    c. one enclosed in a dark matter box
    d. one we can’t see out of
    e. one with critical mass

13. What came before the Big Bang is
    a. described by subnuclear physics
    b. a vexing philosophical question for science, as for religion and other disciplines of thought
    c. another Universe
    d. revealed in our understanding of the Planck era
    e. a sea of quarks that formed the raw material for the Universe

14. How does the average density of the Universe affect its predicted fate?
    a. it makes no difference
    b. if the Universe has a high density, its expansion is expected to reverse and it will collapse
    c. if the Universe has a high density, it will eventually form many more galaxies than now
    d. a high density Universe will have many more stellar collisions
    e. if the density is too high, the Universe will form too many heavy elements
15. To a physicist studying the early Universe, unification is
   a. a political movement to discredit unpopular theories
   b. the concept that the fundamental forces of physics unified under extreme conditions
   c. a theory combining aspects of biology and physics
   d. a merger of observational and theoretical results to get a consistent picture of the early Universe
   e. what the public employees in Wisconsin are demonstrating for

16. The period of very rapid inflation in the early Universe solves the mystery of
   a. why the Universe is so uniform
   b. why the Universe is expanding
   c. why balloons are sometimes used to illustrate the expansion
   d. why there is so much empty space
   e. how the ratio of hydrogen to helium is what it is

17. Hubble's Law implies that
   a. galaxies must be far away
   b. the Universe is expanding
   c. the Universe is open
   d. the other galaxies were shot from the Milky Way
   e. the Universe is not uniform

18. Dark matter
   a. does not really exist
   b. played a critical role in the merger of galaxies in the early Universe
   c. comes from the dark side
   d. no longer exists in significant quantities
   e. is the reason the sky is dark at night

19. The granules visible on the Sun's surface are evidence of
   a. large amounts of iron
   b. convection
   c. magnetic storms
   d. gas escaping into space
   e. electromagnetic radiation from the Sun

20. We are confident the output of the sun has remained nearly constant over billions of years because
   a. the theory of hydrogen fusion indicates so
   b. weather records show little change with time
   c. fossils show similar life forms to some that are still around
   d. the sun is in hydrostatic equilibrium
   e. none of these

21. Iron fusion can produce energy because
   a. at the end the electrons in the atoms have gone to lower energy levels and given off the energy they lost
   b. the atoms join together into bigger molecules, and the molecular binding energy is released
   c. the fusion products weigh a little less than the input materials, and the mass that is lost appears as energy
   d. the high pressure where the fusion takes place yields some of its energy
   e. none of the above

22. The high luminosity stars on the main sequence
   a. are the hottest
   b. have the longest lifetimes
   c. are the least common
   d. have the most helium
   e. both a. and c.
23. The sequence of spectral types that Miss Cannon discovered is actually a sequence  
   a. of percentage of hydrogen in a star  
   b. of velocity through space  
   c. of apparent magnitudes  
   d. of temperatures  
   e. of numbers of sunspots

24. In the figure at the right, which star has the smallest surface area?  
   a. star A  
   b. star B  
   c. star C  
   d. star D  
   e. star E

25. The basic properties that control the current status of a star are  
   a. age, mass, initial composition  
   b. temperature, distance, color  
   c. spectral type, composition, temperature  
   d. distance, magnitude, color  
   e. age, color, spectral type

26. A neutron star is mostly neutrons because  
   a. the protons it used to contain have collected into a proton star  
   b. it has a proton core, but neutrons cover the surface  
   c. the huge pressure has caused its electrons to merge with its protons to make neutrons  
   d. antiprotons have annihilated all the protons it used to contain  
   e. the protons have collapsed into a black hole in its core

27. The Sun will end its life as  
   a. a neutron star  
   b. a pulsar  
   c. a black hole  
   d. a brown dwarf  
   e. none of the above

28. Pulsars vary their light output by  
   a. alternately expanding and contracting  
   b. alternately heating up and cooling off  
   c. sweeping a light beam across our line of sight  
   d. converting H to He  
   e. changing their mass

29. Stars on the main sequence all  
   a. are in hydrostatic equilibrium  
   b. have the same mass  
   c. have the same temperature  
   d. have the same diameter  
   e. there is no property in common among main sequence stars

30. We know that the Crab nebula is a supernova remnant because  
   a. it contains a pulsar  
   b. Chinese astronomers witnessed the explosion  
   c. it emits lots of x-rays  
   d. its gas is moving very rapidly  
   e. all of the above

31. Moderate weight elements like carbon and oxygen are formed  
   a. in the cores of massive stars  
   b. in planetary nebulae  
   c. in main sequence stars  
   d. in supernova explosions  
   e. in white dwarfs
32. The diagram above shows the evolutionary track of a star like the Sun after it leaves the main sequence. At Point A, the star is
   a. burning hydrogen in its core and helium in a shell
   b. burning hydrogen in a shell around a collapsing core
   c. ejecting its outer layers
   d. burning hydrogen in its core
   e. collapsing into a neutron star

33. At point B the star is
   a. burning hydrogen in its core and helium in a shell
   b. burning hydrogen in a shell around a collapsing core
   c. ejecting its outer layers
   d. burning hydrogen in its core
   e. collapsing into a neutron star

34. When matter has been “used up” in a massive star and is ejected, it
   a. is exhausted and plays no further role in the Universe
   b. can form into white dwarfs and neutron stars but no longer can form normal stars
   c. gets caught up in interstellar clouds and eventually may form into new stars
   d. escapes into intergalactic space where it can eventually form new galaxies
   e. none of the above

35. A remarkable observation from the 1987A supernova was
   a. the detection of gravity waves   b. the detection of neutrinos   c. the detection of a pulsar
   d. the detection of a black hole   e. both a. and c.
36. A star will become a red giant when  
   a. it begins to convert H to He  
   b. when its composition changes  
   c. when it can no longer convert H to He in its core  
   d. when it gains mass  
   e. none of the above  

37. If you add mass to a white dwarf to "bulk it up" above 1.4 solar masses,  
   a. it will get smaller and smaller and finally collapse into a neutron star  
   b. it will develop strong coronal lines because of its high surface temperature  
   c. it will increase in radius in proportion to the cube root of the additional mass  
   d. the new matter will cause it to cool on the surface and get fainter  
   e. the matter will disappear beyond its event horizon and we will not know what happens  

38. Your sweetheart (if you have one) is made mostly of  
   a. Sugar and spice and all that’s nice  
   b. Heavy elements built up in the Big Bang  
   c. Stuff from the cores of massive stars  
   d. The products of nova explosions  
   e. Neutrinos and other basic particles  

39. The best way to “weigh” the Universe – see how much mass it contains – is to  
   a. count up all the mass in the galaxies  
   b. use Newton’s and Kepler’s laws  
   c. study the sizes of the faint emission features in the cosmic background radiation  
   d. measure the light output from the dark matter  
   e. wait and see if its expansion continues or slows down  

40. The Sun's output is so stable because  
   a. release of energy by gravitational contraction makes up for any change in the rate of fusion  
   b. the Sun doesn't produce much energy, so its reserves will last a long time  
   c. the Sun rotates fast enough to keep everything inside well mixed  
   d. the Sun has only small sunspots  
   e. the pressure of Sun’s gas just balances gravitational contraction, maintaining constant conditions inside the sun  

41. Most of the helium in the Universe was made  
   a. when the first generation of stars fused their hydrogen into helium  
   b. in reactions in supernova explosions  
   c. it was created at the beginning from fundamental particles  
   d. in ways we are still trying to understand  
   e. in fusion reactions during the first few minutes of the Universe  

42. In the first half of the Twentieth Century, Harvard rose to the top among world observatories because its directors  
   a. Raised money to build a major new telescope  
   b. Hired women astronomers  
   c. Established strong interdisciplinary ties with the physics department  
   d. Moved it to an outstanding site for observations  
   e. Got a lot of funding from the Federal Government  


43. Gravity is an important force in shaping the Universe because
   a. it is the strongest force we know
   b. actually, it does not play much of a role outside the solar system
   c. it holds the protons and neutrons in the nucleus of an atom
   d. it works well over long distances and there is no antigravity
   e. it is the only inverse r squared force

44. The Universe is
   a. open b. at the critical density between open and closed c. closed d. oscillating e. articulating

45. We know that the Universe is only about 4% protons and neutrons - baryons - because
   a. if there were more, the Universe would be closed
   b. fusion reactions in the early Universe would have produced more lithium and maybe heavier elements if there had been more baryons
   c. we don't really know this
   d. because the things around us are made of 4% baryons
   e. from measuring the properties of dark matter

46. The danger to astronauts from solar flares and coronal mass ejections is greatest when
   a. the Sun is at a sunspot maximum b. the magnetic field is least tangled
c. more granules are formed d. the Sun rotates faster
e. the danger is the same all the time

47. Peer-review in science means
   a. Having results checked by a random cross section of the population to be sure they are explained clearly
   b. Selecting a jury of 6 representative scientists to judge whether any scientific ethical standards have been broken in a piece of work
   c. Having work reviewed by elite English noblemen
   d. Having scientist experts in the field evaluate the results and critique them, and requiring any errors identified to be fixed
   e. Posting results on a web site where the scientific community can comment on them

48. Two stars both are at the same temperature. One has a luminosity that is 1000 times larger than the other. What parameter differs the most between these two stars?
   a. temperature b. color c. radius d. composition e. distance

49. The upper limit on the size of a star is set by
   a. the size of cloud fragment that can form b. the gravitational field of a cloud
c. the stability against photon pressure d. there is no upper limit
e. the mass require to get the core hot enough for conversion of Si to Fe

50. Most of the hydrogen was made
   a. in the first generation of massive stars
   b. in thermonuclear reactions in supernova explosions
   c. in thermonuclear reactions in the first few minutes of the Universe
   d. hydrogen was the first element to form from fundamental particles
   e. we do not understand where all the hydrogen came from