Test2 Version A Solutions
Formulae

$$E/_{m^2} = \sigma T^4 \qquad L = 4\pi R^2 \sigma T^4 \qquad L_{ap} = \frac{L}{d^2} = \frac{R^2 \sigma T^4}{d^2} \qquad T = \frac{2.9 \times 10^6}{\lambda_{max}}$$

$$L_{\rm MS} = M^{3.5} \qquad t_{\rm MS} = \frac{1 \times 10^{10}}{M^{2.5}} \,(\text{in years}) \qquad R_{Sch}(\text{km}) = 3M$$

$$\sigma = 5.67 \times 10^{-8}\, W/m^2 \qquad 1\ pc = 3.1 \times 10^{16} m = 3.26 ly \qquad c = 3 \times 10^8 m/s$$

Multiple Choice: *Choose the letter for the best answer.*

1) What stage of evolution is our Sun currently at?
D) Main Sequence.

2) On Figure 2, HR diagram #4, what is the region labeled C?
A) White dwarf.

3) What is the source of energy for a protostar?
C) Gravity.

4) Why do stars evolve?
D) They emit energy, and so use fuel which is a limited resource.

5) What produced all the nitrogen (#7 in the periodic table) in Earth's atmosphere?
A) Supernovas
B) Planetary nebulas
D) Both A & B

6) In HR4 in Figure 2, what is the difference between stars near the letter D and stars near the letter E that *causes* them to be at those locations?
B) Mass.

7) In Figure 2, which of the HR diagrams shows the oldest set of stars?
C) HR3 It has the shortest main sequence.

8) If our Sun became a black hole, how large would its event horizon (Schwarzchild radius) be?
B) 3km: $R_{Sch} = 3M = 3(1) = 3$

9) What is the surface temperature of a star with a peak in its continuous spectrum at 400 nm?
C) 7250 K: $T = 2.9 \times 10^6/\lambda = 2.9 \times 10^6/400 = 7250K$

10) The most common type of exoplanets discovered so far....
B) have masses between Earth's and Neptune's with short orbits.

11) Why does nuclear fusion only occur in the cores of stars?
D) Only the core is hot and dense enough.

12) About what fraction of stars have planets?
D) 90%

13) A star with 34 times the mass of our Sun will end up as...
D) a black hole.

14) I see a red star and a blue star in a binary. The red star is brighter, what else do I know about these two stars?
A) The red star is larger.

Questions 15 - 17 are based on this statement: A gas cloud collapses to form 4 stars (so they all start the main sequence at the same time and ar at the same distance). Star A is 0.08 solar masses, Star B is 1.2 solar masses, Star C is 2.6 solar masses, and Star D is 29 solar masses.

15) Which star is the brightest on the main sequence?
D) Star D: $L_{MS} = M^{3.5}$ so more massive = brighter.

16) Which star evolves the fastest?
D) Star D $T_{MS} = 1 \times 10^{10}/M^{2.5}$ so more massive stars evolve faster.

17) Which stars will become white dwarfs?
B) Stars A, B, and C

Questions 18 through 20 have to do with Figure 1; the star cluster image.
Assume all the stars are in a cluster, so at the same distance.

18) Which star in the image is the brightest?
A) Star A: it has the largest dot.

19) Which star is the hottest?
B) Star B: it is the most blue

20) If Star C and Star D in the image are at the same distance and have the same apparent luminosity, what else do we know about these two stars?
B) Star C is larger than Star D.

Here is a list of stages of stellar evolution for most stars:
A: Main Sequence B: Horizontal Branch C: White dwarf D: Red Giant Branch E: Protostar

Here is a list of energy sources:
I: Fusion of H into He II: Fusion of He into C III: Gravity IV: Electron Degeneracy Pressure
V: Neutron Degeneracy Pressure VI: Supernova

21) Put the steps of stellar evolution (just write the letters) in the correct order from beginning to end for regular (not high-mass) stars.
Next to each step put the roman numeral of its support mechanism (energy in most cases).
(Worth 10 points)
E III
A I
D III
B II
C IV

22) Put the HR diagrams 1-3 of Figure 2 in order from *youngest to oldest*. (Worth 5 points)
1, 2, 3.

23) Put the labeled stars in Figure 1 in order from *hottest to coolest*. (Worth 5 points)
E or B (both blue), D (white), A (yellow), C (orange)