Test 2 Version C

$$L_{ap} = \frac{R^2}{d^2}\sigma T^4 \qquad T = \frac{2.9 \times 10^6}{\lambda_{max}} \qquad R_{\rm Sch} = 3M$$

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

Constants

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

Multiple Choice: Choose the letter for the best answer.

1) How bright (in solar luminosities) is a 4.8 M_{sun} star on the main sequence?
A) 0.5 L_{Sun}
B) 7.8 L_{Sun}
C) 240 L_{Sun}
D) 8,320 L_{Sun}
E) 10 billion years.

2) On Figure 2, HR diagram B, what is the region labeled C?
A) White dwarf.
B) Red Giant Branch.
C) Main Sequence.
D) Planetary nebula.
E) Supernova.

3) What is the temperature of a star if the peak of its spectrum is 550 nm?
A) 6800 K
B) 5300 K.
C) 4100 K.
D) 3600 K.
E) You cannot get temperature from color.

4) The most common type of exoplanets discovered are...
A) Earth-like with orbits around 1AU.
B) Have masses between Earth's and Neptune's with short orbits.
C) Have large masses like Jupiter and have long orbits (like Jupiter's).
D) Have Earth-like masses but with distant orbits.
E) Have large masses like Jupiter and very short orbits (inside Mercury's).

For Questions 5 - 8: A gas cloud collapses to form 4 stars (so they are at the same distance and begin the main sequence at the same time). Star A is 45 M_{Sun}, Star B is 1.4 M_{Sun}, Star C is 9 M_{Sun}, and Star D is 0.5 M_{sun}.

5) Which star is the brightest on the main sequence?
A) Star A
B) Star B
C) Star C
D) Star D
E) They are all the same brightness.

6) Which star remains on the main sequence the longest?
A) Star A
B) Star B
C) Star C
D) Star D
E) They all last the same amount of time.

7) How will star A end?
A) White dwarf.
B) Neutron star.
C) Black hole.
D) Supernova explosion.
E) There is no way to tell.

8) How will star B end?
A) White dwarf.
B) Neutron star.
C) Black hole.
D) Supernova explosion.
E) There is no way to tell.

9) What is the size of the Schwarzschild radius of a 5 solar mass black hole?
A) 5 km.
B) 15 km.
C) 45 km.
D) 150 km.
E) $1.5X10^6$ (1.5 million) km.

10) In Figure 2, which of the HR diagram cluster of stars is the oldest?
A) A
B) B
C) C
D) There is no way to tell.
E) They are all the same age.

11) In Figure 2, HR diagram B, what is the difference between Stars B and D (assuming the same color)?

A) Evolution (Star B is more evolved). **Full credit**
B) Mass (Star B is more massive). **½ credit**
C) Size (Star B is larger). **½ credit**
D) All of the above. **Full credit**
E) None of the above can be determined from the HR diagram. **No credit**

12) What stage of evolution is our Sun currently at?
A) White dwarf.
B) Red Giant.
C) Protostar.
D) Main Sequence.
E) Horizontal Branch.

13) About what fraction of stars have planets?
A) Very few (1%)
B) 25%
C) About half (50%)
D) Nearly all (90%)
E) There is no way to tell.

14) On Figure 2, HR diagram B, what stage of evolution is the letter A?
A) White dwarf.
B) Red Giant Branch.
C) Main Sequence.
D) Horizontal Branch.
E) Supernova.

15) What produced all the oxygen we breathe?
A) Supernovas
B) Planetary nebulas
C) The Universe (it was always around)
D) Both A & B
E) All of the above did.

16) Which method has detected the most exoplanets?
A) Radial velocity (Doppler)
B) Transit
C) Direct imaging.
D) None of these methods have found planets.

17) Stars are roughly made of
A) Mostly H, then He, with a smidge of everything else.
B) Mostly He and rock.
C) Mostly rock like the Earth.
D) Mostly iron core, then a convection zone.
E) Half H and half He.

18) What is the fate of our Sun?
A) It will continue to shine forever.
B) It will eventually explode.
C) It will end up as a white dwarf.
D) It will collapse into a black hole.

19) Why do stars evolve?
A) They have limited fuel, which makes them use other sources.
B) They don't evolve.
C) They merge with other stars and so their mass changes.
D) Because they change color.
E) They turn into planets.

Questions 20 through 25 have to do with Figure 1; the color star cluster image.

20) Which star in the image is the brightest?
A) Star A
B) Star B
C) Star C
D) Star D
E) Star E

21) Which star is the hottest?
A) Star B
B) Star C
C) Star D
D) Star E
E) They are all the same temperature.

22) 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?
A) Star C is closer than Star D.
B) Star C is larger than Star D.
C) Star D is closer than Star C.
D) Star D is larger than Star C.
E) We don't know squat.

23) Stars A and C in the image have the same color.
What else do I know?
A) Star A is smaller than Star C.
B) Star A is closer than Star C.
C) Star A is larger than Star C.
D) Star A is cooler than Star C.
E) Star A is hotter than Star C.

24) If Stars C and D are in a (not eclipsing) binary, what can I learn from that?
A) Mass.
B) Composition.
C) Spectral type.
D) Age.
E) Nothing extra.

25) Since the stars are in a cluster, I can assume that....
A) they are at the same distance.
B) they are the same age.
C) they formed from the same cloud of gas.
D) A, B, and C are all true.
E) None of those can be assumed.

Short Answer Questions (5 pts each)

26) Match the tool with the result. (Just put the letter in the blank.)

A) Color **B)** Binary stars **C)** Parallax **D)** Place (stage) on the HR diagram.

I) Evolution _**D**_ II) Mass _**B**_ III) Temperature _**A**_ IV) Distance _**C**_.

27) Put the lettered HR diagrams of Figure 2 in order from ***youngest to oldest***.

C (longest main sequence), B, A (shortest main sequence)

28) Put stars B, C, D, and E in order from *coolest to hottest*.

29) Next to each step of stellar evolution put the letter corresponding to its energy source (or source stopping collapse): (Just put the letter in the blank.)

A) fusion of H → He, **B)** fusion of He → C/O, **C)** gravity, **D)** electron degeneracy pressure,

E) neutron degeneracy pressure.

I) Protostar _**C**_ II) Main Sequence _**A**_ III) Horizontal Branch _**B**_ IV) Neutron Star _**E**_

30) Put the lettered regions of HR diagram B of Figure 2 in evolution order from ***first to last***.

D (Main sequence), B (red giants), A (horizontal branch), C (white dwarf)