Matching: Match the object in column A with the correct description in column B. Its in column B can be used only once. (1 point each)

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main Sequence</td>
<td>A. energy source for the Sun</td>
</tr>
<tr>
<td>2. Red giant</td>
<td>B. made entirely of neutrons</td>
</tr>
<tr>
<td>3. Supergiant</td>
<td>C. cool, red, faint star</td>
</tr>
<tr>
<td>4. White dwarf</td>
<td>D. hot, outermost layer of the Sun</td>
</tr>
<tr>
<td>5. Neutron star</td>
<td>E. energy source for Red Giant stars</td>
</tr>
<tr>
<td>6. Black Hole</td>
<td>F. what Sun will become after Hydrogen fusion</td>
</tr>
<tr>
<td>7. O main sequence star</td>
<td>G. star that is compressed to an infinitesimal point</td>
</tr>
<tr>
<td>8. M main sequence star</td>
<td>H. appears as dark patch on surface of sun</td>
</tr>
<tr>
<td>9. Blackbody</td>
<td>I. outer layers of star that are thrown off near end of its life</td>
</tr>
<tr>
<td>10. Corona</td>
<td>J. where sunlight we see originates</td>
</tr>
<tr>
<td>11. Sun spot</td>
<td>K. what an O star will become after Hydrogen fusion</td>
</tr>
<tr>
<td>12. Photosphere</td>
<td>L. hot, blue, luminous star</td>
</tr>
<tr>
<td>13. Planetary Nebula</td>
<td>M. stars that are burning Hydrogen into Helium</td>
</tr>
<tr>
<td>14. Hydrogen Fusion</td>
<td>N. supported by electron degeneracy pressure</td>
</tr>
<tr>
<td>15. Helium Fusion</td>
<td>O. underlying spectrum emitted by stars</td>
</tr>
</tbody>
</table>

Multiple Choice: Choose the letter that best answers each question. (1 point each)

17. Two burners on a stove have the same size. Burner 1 is on high, and burner 2 is on medium. Which burner has a higher energy output?
   a. Burner 1
   b. Burner 2
   c. Not enough information to tell

18. Consider two burners on a stove. Burner 1 is larger and cooler. Burner 2 is smaller and hotter. Which burner has the higher energy output?
   a. Burner 1
   b. Burner 2
   c. Not enough information to tell

19. By tracking the location of sun spots over time, what property of the sun can you measure?
   a. Granulation
   b. Rotation
   c. Convection
   d. Revolution

20. Which type of main sequence star has the longest lifetime?
   a. O
   b. G
   c. K
   d. A

21. What is the average life-span of a G star (sun)?
   a. 100 billion years
   b. 10 billion years
   c. 1 billion years
   d. 100 million years

22. What factors contribute to a star’s luminosity?
   a. Size and distance
   b. Temperature and size
   c. Distance and temperature

23. The distances of nearer stars may be measured by observing their apparent motion as
   a. the Earth orbits around the Sun.
   b. the Earth rotates on its axis.
   c. the Sun orbits around the center of the Galaxy.
   d. the planets cross their path.
24. If two intrinsically identical stars are at different distances from the Earth, the more distant star will have
   a. bluer color.
   b. higher luminosity
   c. lower luminosity
   d. lower apparent flux.
25. A hot, glowing, opaque solid, liquid or gas emits which type of spectrum?
   a. Continuous.
   b. Emission lines.
   c. Absorption lines.
26. A hot, glowing, opaque solid surrounded by a cool gas will show
   a. continuous emission.
   b. emission lines.
   c. absorption lines.
   d. both emission lines and absorption lines.
27. The energy emitted by the Sun is produced
   a. in a very small region at the very center of the Sun.
   b. uniformly throughout the whole Sun.
   c. throughout the whole Sun, but more in the center than at the surface
   d. from radioactive elements created in the Big Bang.
28. The chemical composition of the Sun 3 billion years ago was different from what it is now in that it had
   a. more hydrogen.
   b. more helium.
   c. more nitrogen.
   d. molecular hydrogen.
29. Tremendous pressure is created at the Sun's center due to its own gravity. The Sun is kept from collapsing by
   a. neutrinos and other particles generated by nuclear fusion.
   b. a hard inner core.
   c. thermal (gas) pressure generated by nuclear fusion.
   d. thermal (gas) pressure left over from the formation of the Sun.
30. Which is the correct order for the layers of the sun’s atmosphere, from inner most to outer most:
   a. Photosphere, chromosphere, corona
   b. Corona, photosphere, chromosphere
   c. Chromosphere, photosphere, corona
   d. Photosphere, corona, chromosphere
**Long Answer:** Answer the following questions. Use complete sentences and be sure to express complete thoughts.

1. Explain how the main sequence is fundamentally a mass sequence. Describe how stellar luminosity, temperature, and main-sequence lifetime vary along the main sequence. Explain why stellar luminosities, temperatures, and lifetimes depend on a star’s mass.  **(12 points)**
2. Base your answers to the following questions on the spectra for star A and B below.

![Spectra of Star A and B](image)

a. Which star has a higher surface temperature? Explain. (3 points)

b. Which star has a higher energy output? Explain. (3 points)

c. Which star is larger? Explain. (3 points)
3. Draw an H-R diagram. Label the horizontal and vertical axis. Label the main sequence, red giants, supergiants, and white dwarfs. (10 points)

a. Draw the path of Sun on your H-R diagram as it evolves from protostar to its final end state. (4 points)

b. Explain what is happening at each point in the Sun’s evolution. Be sure to explain why the transition to each new evolutionary state changes the sun’s location on the H-R diagram. (11 points)
4. Complete the following concept map using the following terms: neutron star, black hole, planetary nebula, white dwarf, black dwarf, nova, Type II supernova, Type I supernova, X-ray source (10 points)

5.
   a. List 3 requirements for life and explain why they are necessary. (6 points)

   b. Give 3 factors that need to be considered when calculating the likelihood that other life exists in our galaxy and explain how well each factor can be estimated. (6 points)