Chapter 12

Evolution of Low-Mass Stars
Consider the information given below about the lifetime of three main sequence stars:

- Star A will be on the MS for 45,000 million years.
- Star B will be on the MS for 70 million years.
- Star C will be on the MS for 2 million years.

Which of the following is a true statement about these stars?

A. Star A has the greatest mass.
B. Star C has the greatest mass.
C. Stars A, B, and C all have approximately the same mass.
D. There is not enough information to determine the answer.

<table>
<thead>
<tr>
<th>Mass of the Star (in multiples of Sun masses, $M_{\text{sun}}$)</th>
<th>Approximate Main Sequence Lifetime of the Star</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 $M_{\text{sun}}$</td>
<td>50 billion years</td>
</tr>
<tr>
<td>1.0 $M_{\text{sun}}$</td>
<td>10 billion years</td>
</tr>
<tr>
<td>2.0 $M_{\text{sun}}$</td>
<td>2 billion years</td>
</tr>
<tr>
<td>6.0 $M_{\text{sun}}$</td>
<td>110 million years</td>
</tr>
<tr>
<td>60 $M_{\text{sun}}$</td>
<td>360 thousand years</td>
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</table>
Which of the following statements best describes how the lifetimes compare between the Sun and a star containing 3 times more mass than the Sun?

A. The Sun will live more than three times longer than the other star.
B. The Sun will live three times longer than the other star.
C. The two stars will have the same lifetime.
D. The Sun will live three times shorter than the other star.
E. The Sun will live less than three times as long as the other star.
When a star runs out of fuel in its core, the core shrinks. Gravity and pressure increase resulting in faster nuclear burning and

a. smaller size

b. higher surface temperature

c. greater luminosity

d. less energy produced
When a red giant suddenly starts burning Helium in its core, that is called __________.

a. A hydrogen shell

b. A helium bump

c. A hydrogen burn

d. A helium flash

Stars on the Horizontal Branch of the HR diagram, have a constant __________.

A. Temperature

B. Luminosity

C. Size

D. Mass
Which type of star has a degenerate Carbon core?

A. Red Giant
B. Horizontal Branch Star
C. AGB Star
D. Main Sequence Star
The Sun now

M = $1.0 \ M_{\odot}$
R = 1.02 $R_{\odot}$
$V_{\text{max}} = 0.02c$

The Sun as a
White Dwarf
(at $t = 0$ years from now)
Which of the following is the correct order for the stages of evolution of the Sun?

A. Main sequence, white dwarf, planetary nebula, red giant.
B. Main sequence, red giant, white dwarf, planetary nebula.
C. Main sequence, red giant, planetary nebula, white dwarf.
D. Main sequence, planetary nebula, red giant, white dwarf.
When will the Sun leave the main sequence?

A. When hydrogen is exhausted in the core.
B. When all the Sun’s hydrogen becomes helium.
C. When carbon fusion begins.
D. When it becomes an AGB star.
1. Two low-mass main-sequence stars orbit their center of mass.

2. The more massive star 1 begins to evolve...

3. ... until it overflows its Roche lobe and begins transferring mass onto its companion star 2.

4. Star 2 gains mass, becoming a hotter, more luminous main-sequence star.

5. Eventually star 1 leaves behind a white dwarf orbiting together with the now more massive main-sequence star 2.

6. When star 2 evolves beyond the main sequence, it too overflows its Roche lobe and begins transferring mass onto its white dwarf companion.
A binary begins with a 2 $M_\odot$ and a 1 $M_\odot$ star. Which of the following states is NOT possible later on?

A. Two white dwarf stars.
B. A white dwarf and a main-sequence star.
C. Two AGB stars.
D. A white dwarf and a red giant.