Star in a Box
The Lifecycle of Stars

☆ Go To http://lcogt.net/siab/
☆ Open the lid of your 'Star in a Box'.
☆ The graph is a Hertzsprung-Russell diagram, where a star's luminosity is plotted against its temperature.
☆ The information panels allow you to compare the Sun with your star. It compares the relative radius, surface temperature, brightness (luminosity) and mass of the star to the Sun.

A. The Sun's Evolution during its lifetime.

☆ Click the play button below the Hertzsprung-Russell diagram to show the Sun's evolution.

1. Describe how the Sun changes over its lifetime.
2. In which stage of its life does the Sun spend the longest time?
3. In which stage of life will the Sun undergo the most change?
4. What kind of star will the Sun be at the end of its life?
5. Name the three stages of the Sun's life shown on the Hertzsprung –Russell diagram.

Stage 1: .....

Stage 2: .....

Stage 3: .....

☆ Use the table below to describe the changes the Sun will go through between stages.

6. Add '**Increase**', '**Decrease**' or '**Stay the same'** for each of the quantities in the table along with the values they change from and to.

	Radius	Luminosity	Temperature	Mass
Stage 1 to Stage 2	..... From:..... R_{Sun} To: :..... R_{Sun}	..... From:..... L_{Sun} To:..... L_{Sun}	..... From:..... K To: .....K	..... From:..... M_{Sun} To:..... M_{Sun}
Stage 2 to Stage 3	.....Increase..... From:..... R_{Sun} To: :..... R_{Sun}	.....Increase..... From:..... L_{Sun} To:..... L_{Sun}	.....Increase..... From:..... K To: .....K	.....Increase..... From:..... M_{Sun} To:..... M_{Sun}

7. Look at the light bulb tab:
    a. At which stage in its lifecycle will the Sun be at its brightest?
    b. How old will the Sun be at this point?
8. Look at the thermometer tab:
    a. At which stage in its lifecycle will the Sun be at its hottest?
    b. What is its maximum temperature?

9. Look at the pie chart tab:
    a. In which stage of its life will the Sun spend most of its time?
    b. How long will it spend in this stage?
10. Look at the mass tab:
    What happens to the mass of the Sun as it gets older?
11. What type of star will the Sun be at the end of its life?
12. What is the total lifetime of the Sun?

B. Using the 'Star Properties' banner, explore the evolution of stars with different starting masses.

☆ Select a different starting mass for your star in the 'Star Properties' banner.
☆ Use the Hertzsprung-Russell diagram tab, click play to watch your new stars evolution.
☆ Try out a few different masses then answer the following questions.

1. Using the Hertzsprung-Russell diagram:
    a. Where on the main sequence do the lower mass stars start?
    b. Where on the main sequence do the higher mass stars start?
2. There are three possible outcomes for the final stage of a stars life depending on its initial mass. Name these 3 possible final stages.

C. Follow the evolution of 5 different mass stars.

☆ Complete the table below, filling in a row for each of the different masses.

Hint: You may find it easier to use the data table on the 'Star in a Box' to find the exact values.

Mass of star (M_{Sun})	Time on main sequence (Myr)	Number of stages	Final state	Total lifespan (Myr)	Maximum radius (R_{Sun})	Maximum luminosity (L_{Sun})	Maximum temperature (K)

D. Study the data for the different stars in your table above.

1. Comparing the temperatures:
    a. Which mass star reaches the highest temperature?
    b. Which mass star gets the coolest?
    c. At what stage in its life does the star reach this temperature?

2. Comparing the luminosities:

a. Which mass star gets the most luminous (brightest)?
b. Is this the same mass of star that reaches the highest temperature?

E. Multiple choice questions.

☆ Write in the correct answer.

1. What type of star will the Sun become after it leaves the Main Sequence?

Neutron Star Red Dwarf Red Giant Red Supergiant

2. What main factor determines the stages a star will follow after the main sequence?

Mass Luminosity Temperature Radius

3. The mass of the star Betelgeuse is much greater than the mass of the Sun, therefore its total lifetime will be

Greater than the Sun The same as the Sun Less than the Sun

4. Compared to when it joins the Main Sequence, a star's mass at the end of its life will

Be greater Be the same Be less Depend on the type of star

5. The Sun will spend most of its life in what stage?

Main Sequence Red Giant Red Dwarf White Dwarf

F. Comparing.

A. *Deneb and Betelgeuse are both 20x the mass of the Sun, but look very different. Deneb has 100 times the radius of the Sun and its temperature is about 8000 K. Betelgeuse has 1000 times the radius of the Sun and its temperature is about 3500 K.*

Select a star with 20x the mass of the Sun and run the animation, use this to find:

1. What stages of their lives the two stars are in.

2. How long each star has to live.

G. Stretch and Challenge

☆ Find out, using the internet (or books!)…

Why is the maximum temperature of the $40M_{sun}$ star less than the maximum temperature of the $20\ M_{sun}$ star?

Hint: Consider the different stages these two stars will go through during their lifetime, and the properties of the final stages.