Star in a Box

The Lifecycle of Stars

* Open the following link in a web browser <https://starinabox.lco.global>
* 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 comparison between the radius, surface temperature, brightness (luminosity) and mass of the star relative to the Sun.

# A. 1 Solar Mass Star

* Press play to watch the evolution of your star on the Hertzsprung-Russell diagram.
* Click on the data table tab and download the CSV file for your 1 Solar mass star and save it in a spread sheet.
* Using Excel, plot graphs of Mass, Luminosity, Surface Temperature and Radius against time.
1. Describe how the Luminosity of this star changes with time.

1. Describe how the radius of this star changes with time.

1. Describe how the mass of this star changes with time.

1. Describe how the surface temperature of this star changes with time.

1. At around 10,000 Myr the stars life changes stage. What are the names of the stages it changes from and to?

# B. Stretch and Challenge

* You may need to refer to textbooks or the internet to answer these questions.
1. If you zoom in on the peaks of the luminosity and radius graphs, you will see that there are in fact two peaks. Suggest why you think this happens.

1. Using your knowledge of processes involved during this stars lifecycle, explain what is happening within the core of the star to cause the sudden changes in luminosity and temperature?

1. What happens to the mass that is lost from the star after the red giant stage?

# C. 30 Solar Mass Star

* Using the ‘Star Properties’ banner, select a star with a starting mass of 30 Msun.
* Press play to watch the evolution of your new star on the Hertzsprung-Russell diagram.
* Click on the data table tab and download the CSV file for your 30 Solar Mass star and plot the same graphs as in part A.
1. How does the luminosity graph for the 30 solar mass star compare with the luminosity graph from the 1 solar mass star? State the differences in timescale and the changes in luminosity.

1. Compare how the mass of these two stars changes,
	1. During their time spent on the main sequence?

* 1. Over their whole lifetime?

# D. Wien’s Law

* Using the data table on the Star in a Box website and your knowledge of Wien’s Law, complete the following table.

*Wien’s Law: λmax T = 2.898 x10-3  m.K*

|  |  |  |  |
| --- | --- | --- | --- |
| Mass of Star (Msun) | Main Sequence Temperature (K) | Main Sequence λmax (μm) | Region of EM spectrum |
| 1 |  |  |  |
| 2 |  |  |  |
| 6 |  |  |  |
| 10 |  |  |  |
| 20 |  |  |  |
| 30 |  |  |  |
| 40 |  |  |  |

# E. Stefan-Boltzmann Law

* Using the data table on the Star in a Box, complete the following table.

*HINTS: Assume all the stars are spherical.*

*You will need to convert some of the values into SI units.*

*Lsun = 3.8 x 1026 W Rsun = 3 x 108 m Stefan’s Law:* $L= σ A T^{4}$

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mass of Star (Msun) | Main Sequence Temperature (K) | Main Sequence Radius (Rsun) | Main Sequence Radius (m) | Surface Area of Main Sequence Star (m2) | Main Sequence Luminosity (Lsun) | Main Sequence Luminosity (W) |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |
| 40 |  |  |  |  |  |  |

* Calculate the Stefan-Boltzmann constant.
1. What quantities will you need to plot on the x and y axis in order to produce a straight line graph, with a gradient equal to the Stefan-Boltzmann constant?

1. Using the data in your table above and the quantities you suggested in question 1, draw a graph in Excel to calculate an approximate value for the Stefan-Boltzmann constant σ.

Gradient of straight line graph = Stefan-Boltzmann constant = W m-2 K-4

# F. Multiple Choice Questions

* Circle the correct answer.
1. On a Hertzsprung-Russell diagram, white dwarfs are found in the

Top Left Corner Top Right Corner Bottom Left Corner Bottom Right Corner

1. Compared to white dwarf stars, Red Giant stars are

Hotter and Brighter Hotter and Dimmer Cooler and Brighter Cooler and Dimmer

1. For two stars with the same radius, the star with the greater surface temperature will have a greater luminosity.

True False It depends on the mass of the star

1. At the end of its life, a star with an initial mass of 40 Solar Masses will become

A white dwarf A Red Giant A Supernova A Black Hole

1. Which of the following statements is true for a star on the Main sequence?
2. The inward gravitational force is greater than the outward radiation pressure.
3. Hydrogen fusion is occurring within the stars core to create Helium.
4. Hydrogen fusion is occurring within the star’s core to create heavy elements e.g. Carbon.
5. The star is at its maximum radius.